ROYAL COMMISSION
ON
ENVIRONMENTAL POLLUTION

CHAIRMAN: SIR RICHARD SOUTHWOOD

TENTH REPORT

TACKLING POLLUTION–EXPERIENCE AND PROSPECTS

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ROYAL COMMISSION
ON
ENVIRONMENTAL POLLUTION

TENTH REPORT

To the Queen's Most Excellent Majesty

MAY IT PLEASE YOUR MAJESTY

We, the undersigned Commissioners, having been appointed "to advise on matters, both national and international, concerning the pollution of the environment; on the adequacy of research in this field; and the future possibilities of danger to the environment";

And to enquire into any such matters referred to us by one of Your Majesty's Secretaries of State or by one of Your Majesty's Ministers, or any other such matters on which we ourselves shall deem it expedient to advise:

HUMBLY SUBMIT TO YOUR MAJESTY THE FOLLOWING REPORT.

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CHAPTER I

THE COMMISSION AND ITS TASKS

The environment is everything that isn't me.
Einstein

Origins and nature of this Report

1.1 As its title implies, this Report looks back as well as forward. Two years ago we decided that it would be timely, as the standing Royal Commission approached its twelfth year, to conduct a broad review of current issues of environmental pollution. The review would initially be open-ended and constrained only by our generously-drawn terms of reference.

1.2 The Commission had attempted such a task twice before: first, in 1970, as a newly appointed body under Lord Ashby's chairmanship, it examined the fundamental problems, identified priorities and defined the Commission's role(1). Secondly, in 1974, under the chairmanship of Lord Flowers, the Commission published, as its Fourth Report(2), a comprehensive review of recent changes in the environment and a programme of future studies. That report was followed by four detailed reports on specific aspects of pollution—Air Pollution Control(3), Nuclear Power and the Environment(4), Agriculture and Pollution (5) and Oil Pollution of the Sea(6).

1.3 We felt it would be right to take stock once again. As the first step we invited a wide range of organisations and individuals to give us their views on the aspects of pollution which they perceived to pose the greatest threat to the environment and to comment on some provisional suggestions of our own on the topics most deserving of study. We also met a number of bodies and individuals for informal discussions. In the light of these initial consultations, we invited detailed evidence on three major topics—environmental lead pollution; pollution of estuaries, coastal waters and the North Sea; and atmospheric pollution.

1.4 As our inquiries progressed, we came to the conclusion that it would be appropriate to report separately, and urgently, on the first of those three topics. Our Ninth Report, 'Lead in the Environment'(7), was published in April 1983 and drew from the Government an immediate response(8), which accepted our recommendations for phasing out lead in petrol. This was followed, just over three months later, by a detailed response(9) to our recommendations on other sources and pathways of lead in the environment and on requirements for further research.

1.5 In this Report we discuss the issues other than lead pollution that emerged from our wider review. It is a deliberately selective report, which does not set out to examine particular aspects of environmental pollution in the same degree of depth as the previous four reports. Nor is it a comprehensive 'state of the environment' report. Instead we have selected the issues which seemed to us to provide the most telling illustrations of general principles, drawing on the much wider range of data and opinion gathered over the past two years. We have also in many instances considered topics which would not otherwise be covered in a Royal Commission report in the near future. Our aims have been to recapture the spirit of the First Report; to update some of its findings in the light of collective experience over nearly 13 years and the many changes which have occurred during that time, not the least of which has been the United Kingdom's accession to the European Community; to comment on future trends and prospects; and to set out certain general principles which we hope may serve as points of reference for the future.

The Royal Commission's role

1.6 The Commission was constituted on 20 February 1970, as a standing body, 'to advise on matters, both national and international, concerning the pollution of the environment; on the adequacy of research in this field; and the future possibilities of danger to the environment'. Appointments to the Commission are by Royal Warrant, on the advice of the Prime Minister. There is thus an important distinction to be drawn between the Commission's status, as an independent body not constrained by departmental boundaries, and that of an advisory committee appointed by a Minister to advise him on matters falling within his departmental responsibilities. As the First Report(1) stated: 'We have no specific or restricted task. We are authorised to enquire into any matter on which we think advice is needed, and also to enquire into any issues within our terms of reference that are referred to us by any of Her Majesty's Secretaries of State or Ministers.'

1.7 To quote again from the First Report:

> 'We regard it as our function to find out what is happening to our physical environment and to inform the British public about trends in pollution and needs for research and development. We expect to propose ways to improve the quality of the environment through education, legislation, financial measures and international agreements... The nation's resources for reducing pollution are limited; difficult choices will have to be made in their deployment. A standing Royal Commission, which is independent of Government, has an opportunity to give objective advice on how these choices should be made and to contribute ideas toward a comprehensive policy for safeguarding the environment.'

1.8 This theme was developed in the Fourth Report(2), which (after noting the steady improvements in environmental protection introduced by successive governments) commented:

> 'The existence of a standing Royal Commission with such broad terms of reference implies a judgment that pollution will continue to raise issues of

> such consequence to the nation as to justify an independent 'watch-dog' body. Our role . . . is to identify aspects of pollution that appear to call for independent enquiry, to study these in depth and to publish our conclusions. We see it as an important part of this work to inform the general public on environmental matters as well as to recommend action by Government and other agencies where we consider that this is needed. Though we are essentially a lay body, we bring a wide range of experience and expertise to the Commission, and we are in a position to take a comprehensive view of the issues raised by pollution . . . We expect . . . to concern ourselves with the principles that relate to pollution control and abatement and to deal with matters which may escape the attention of official bodies having more narrowly defined responsibilities than those of the Commission, but which may nevertheless be of considerable importance for the future protection of the environment.'

We believe that these statements are as valid today as they were when they were first written.

What is 'pollution'?

1.9 In our consultations various bodies or persons have urged us to look at topics which lie outside the general area previously covered by the Commission. It may therefore be helpful to consider what the Commission understands by environmental pollution. While we do not consider that it is either practicable or helpful to seek a comprehensive simple definition of 'pollution' to apply to every occasion, we find the following to be a useful working definition:

> 'The introduction by man into the environment of substances or energy liable to cause hazards to human health, harm to living resources and ecological systems, damage to structures or amenity, or interference with legitimate uses of the environment.'(10)

In practice the word 'pollution' is used both to describe the act of polluting and the consequences.

1.10 It is implicit in the above definition that pollution is not simply the presence in the environment of an alien substance or other unnatural disturbance; there must also be an unwanted effect. Substances introduced into the environment become pollutants only when 'their distribution, concentration or physical behaviour are such as to have undesirable or deleterious consequences'(11). For many substances whether a particular discharge or emission is considered to be pollution depends not only on the nature of the substance, but also on the circumstances in which it occurs, and often on the attitude of people affected and on value judgments.

1.11 In this Report we have used the words 'contamination' or 'contaminant' in circumstances where we need to refer to the introduction or presence in the environment of alien substances or energy but do not wish to pass judgment on whether they cause, or are liable to cause, damage or harm.

In so doing we have not followed the sharp distinction which some authors of technical literature on environmental pollution draw between 'pollution' and 'contamination'—the latter being used in a semi-technical sense to describe situations where substances are believed (or positively asserted) to be harmless or not present in sufficient quantities or concentrations to cause damage. Instances of this usage can be found in the evidence submitted to us (see paragraphs 2.39 and 3.15).

1.12 We therefore see 'contamination' as a necessary but not a sufficient condition for 'pollution': there is a complex continuum, depending on many factors, between what people would generally agree to be mere contamination (such as cooking smells) and what is clearly also pollution (such as choking fumes from burning plastic). What today is regarded as no more than contamination may tomorrow be pollution as a substance accumulates in the environment to what are harmful concentrations, or as knowledge is gained of hitherto unsuspected effects. Behind several European Community water directives is the belief that some substances, on the basis of their toxicity, persistence and bioaccumulation, should be considered pollutants even at very low concentrations in the environment. Directive 80/68/EEC(12), concerned with protection of groundwaters, has a 'black list' or List I* of dangerous substances, direct discharges of which to groundwaters (with certain exceptions) are to be prohibited. Directive 76/464/EEC(13), dealing with dangerous substances in water, also has a 'black list' for which particularly strict limit values or environmental quality standards (as alternative options for Member States) (see box on page 49) are set by 'daughter' directives.

1.13 When considering the damage caused by a pollutant it is not enough to think only of harm to human health(14). There are several reasons why we are concerned with harm to the environment as a whole and not simply with harm to human health, welfare and amenity. Harm to other forms of life can serve as an advance warning of future harm to man, and any reduction in the number of species or in genetic diversity may place constraints on man's future options for development, for example in agriculture. Furthermore, we subscribe to the ethical view that man must exercise responsible stewardship of the environment. A recent discussion of this view may be found in the United Kingdom response to the World Conservation Strategy(15). It is not, of course, a view which advocates resistance to change: change is inevitable and the environment has a natural, though finite, capacity to adapt to all sorts of pressures. However, the severity of the stresses induced by pollution may not always give the environment sufficient time to adapt before long-term or permanent damage is done. In consequence options may be closed for future generations.

1.14 Given that the word 'pollution' needs to accommodate a wide range of concepts, we need to consider whether, for the practical purposes of the Commission's studies, we should deliberately refrain from venturing to its extremities. There has, for instance, been some discussion in the past on whether land dereliction should be considered to lie within the Commission's terms of reference, although clearly it comes within any definition of pollution that includes damage to amenity. As a watch-dog body we need to maintain a general surveillance over the wider field, because problems are never static and we may find that we have a contribution to make in areas which we have hitherto been content to leave to others. We reaffirm the view of our predecessors that we should not report on pollution in the workplace, in the context of safety at work. However, pollutants in the workplace (as well as deliberate discharges or emissions) may pass into the general environment by a number of pathways, such as in dust on the clothes of employees, on the tyres of motor vehicles or simply blown by the wind. Furthermore, there are many instances where knowledge gained of occupational exposure to pollutants (for example, lead and asbestos) advances understanding of the hazards of environmental exposure.

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*The lists of dangerous substances in Directives 80/68/EEC and 76/464/EEC and in the Oslo and Paris Conventions (see paragraphs 4.81–4.82) are similar but not identical.

1.15 We would also tend not to involve ourselves in issues essentially of conservation, such as threats to particular habitats through land use changes, although we would not rule out the possibility of our acting as a long-stop to draw attention to any striking weaknesses in our institutional arrangements.

1.16 The interaction between pollution control and the land use planning and development control system is a topic which has interested the Commission in the past and is pertinent to many of the issues we have been studying. Environmental impact is one of several factors which need to be taken into account in strategic planning and at all stages of development control. Our concern is to ensure that it is given due weight. Like the Commission under the chairmanship of Lord Flowers, we consider this to be particularly important in the field of energy policy. With this in mind, the Sixth Report(4) recommended the establishment of a standing advisory body on energy strategy, taking account of economic, social, technical and environmental considerations. The Commission on Energy and the Environment, established in response to that recommendation, is at present 'in abeyance'. We discuss this in Chapter V (paragraphs 5.141–5.144).

1.17 Although environmental aspects are frequently aired at public inquiries into major development proposals, in practice there is no formal requirement for a planning inspector to consider the full range of environmental effects, or 'impacts'. We can therefore see positive advantages in the element of discipline which a formal system of environmental assessment would introduce. The apparent lack of progress being made until recently towards agreement on the proposed European Community Directive on the environmental assessment of development projects(16)—a delay for which the United Kingdom was at least in part responsible—was a matter of some concern to us, and we feared that further delay might be damaging to Community environmental policy as a whole. The Council of Environment Ministers in June 1983(17) agreed the contents of the list of projects for which an assessment would be mandatory and resolved a number of procedural points. It seems likely that agreement will be reached on the whole Directive in the near future: when that comes, the broad commitment behind it may prove to be more significant than the finer points of drafting about which there has been so much discussion.

The experience of the past decade

1.18 As we have said, we think it is important, in taking stock of the present situation, to identify the main changes which have occurred since the Commission was established; and in the chapters which follow we consider their implications from a number of different angles—notably in relation to economic factors, public and political attitudes, the characteristics and relative importance of outstanding pollution problems, the international dimension, and the institutional framework for pollution control.

1.19 The economic climate has changed considerably over the past decade. At the time of the First Report sustained economic growth was still widely forecast, with consequent fears about the dangers of resource depletion and energy shortages. The issue today, when energy consumption is at the same level as ten years ago(18), is not so much how to curb the effects of unbridled growth but to ensure a return to steady economic and technical development in parallel with continued protection of and improvements to the quality of the environment. Choosing the most cost-effective means of controlling pollution is a question of ever-growing urgency; and, as the covering Resolution on the European Community's Third Action Programme on the Environment (see paragraph 3.7 *et seq*.) recognised, 'a harmonious development of economic activities and a continuous and balanced expansion . . . throughout the Community . . ., even in changed economic circumstances, is inconceivable without making the most economic use possible of the natural resources offered by the environment and without improving the quality of life and the protection of the environment'(19).

1.20 There has been a general growth in public awareness of environmental problems and pressure for action, despite some conspicuous successes in tackling the grosser, traditional forms of pollution. Objective measures of public opinion are, however, difficult to come by. A European Community opinion survey in 1980 produced the finding that 93 per cent of those polled agreed with the proposition that stronger measures should be taken to protect the environment against pollution(20). In Great Britain, responses to a poll conducted by MORI in January 1983 as part of the United Kingdom response to the World Conservation Strategy(21) indicated that environmental concern was fairly uniformly distributed across age, socio-economic and political groupings, although generally ranked below the more immediate social and economic concerns of unemployment, inflation and law and order.

1.21 Further recognition of this sustained concern, despite fears that governments in both Europe and North America might be content to see reduced public sensitivity to questions of pollution at a time of economic difficulty, was shown by the extent to which 'the environment' featured in the manifestos for the United Kingdom General Election of June 1983. Other indications of strong interest in environmental and conservation matters in the United Kingdom can be seen from the marked growth in membership of voluntary environmental groups(22); while in continental Europe the 'greens' are now a political force. There are also parallels with the US Environmental Protection Agency's reassertion, backed by Congress, of its strong interventionist role. The development of a series of environment action programmes by the European Community can be seen as contributing to the same trend. Nor is the trend confined to the developed nations of North America, Western Europe and Japan: we have seen evidence of awareness and concern in many Eastern European and developing countries, including China, though the attitudes and priorities may differ from those in the West.

1.22 Whilst we welcome these developments in general, we must also sound a warning against precipitate action. Public opinion, which is now assuming international dimensions on many issues, is a vital formative influence on policy. But emotion should not be allowed to usurp the best informed judgment. The widespread zeal and pressure for instant action on popular environmental causes is understandable and in many cases may well be justified. However, policy which is allowed to become too far ahead of evidence and action which is taken without due consideration of its possible consequences may be counter-productive to the cause of environmental protection. We return to the question of public attitudes in Chapter II.

1.23 The growth of environmental awareness has occurred at a time when most of the major industrial countries have made substantial progress in tackling the most obvious forms of pollution. In the United Kingdom the most significant achievement has been the steady improvement in air quality following the Clean Air Act of 1956(23). There have also been notable improvements in river and estuary quality, on which earlier reports of the Royal Commission can be claimed to have had some influence. We survey recent developments in these fields in Chapters IV and V. The focus of attention, however, has shifted in that many of the remaining pollution problems—both traditional and newly-perceived—have assumed both national and international proportions. The timescale of their emergence and of the measures needed for tackling them is often very long; and the cross-media* nature of many forms of pollution may call for new institutional arrangements and control methods. In the air pollution field the Royal Commission recognised the need for such a shift of emphasis in its Fifth Report, published in January 1976(3). We believe that the recommendations of the Fifth Report are relevant to the problems of the 1980s and 1990s to an extent which successive United Kingdom governments have perhaps insufficiently acknowledged—in particular the principle of 'best practicable environmental option' and the procedures and institutional arrangements needed for achieving it. We are pleased to note the Government's acceptance of this principle(24). It is in fact a theme which runs through much of the present Report.

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*We use the term 'cross-media' (or 'trans-sectoral') to describe the propensity of pollutants to pass from one environmental medium to another or to affect more than one medium simultaneously (see paragraphs 5.78 and 6.33–6.35 for examples).

1.24 The growing international dimension of environmental protection is a logical outcome of the developments we have mentioned. The transfrontier nature of many of the more complex and long-term pollution problems means that international co-operation is essential. This is not an easy task when there are many differences in national attitudes, practices and institutional arrangements. Nevertheless, significant progress has been made over the past decade; and the United Kingdom's international obligations, particularly towards the European Community, have had an increasing impact on domestic pollution control policy(25). We are worried, however, that the United Kingdom's commitment to international action has not always been as strong as it might have been and that, on occasion, reluctance to accept a majority view in the interests of the European Community may have harmed the United Kingdom's international standing. We see a need for more positive attitudes and a willingness to seize the initiative, particularly within the European Community, not merely to ensure that national interests are best served but also to give a lead internationally on best possible practice in tackling pollution. At the same time, it is not too harsh to say that some of the European Commission's initiatives have been flawed both scientifically and in their drafting, and some unsatisfactory features have become enshrined in Community legislation.

1.25 These issues are discussed in Chapter III, where we also consider the effectiveness of the present institutional arrangements in the United Kingdom. During the 13 years since the Royal Commission was set up there have been a number of improvements, some of which have at least partly been due to recommendations made by the Commission. In some areas, however, there has been a weakening of institutional safeguards. In Chapter VI we turn to the question whether more fundamental changes in the approach to pollution control are needed to meet new priorities in the future.

CHAPTER II

ATTITUDES AND RISKS

Government . . . cannot be wiser than the people.
Adlai Stevenson, 29 September 1952

Introduction

2.1 Our Ninth Report(7) provides a good illustration of how environmental policy decisions can depend on the assessment of risks. The evidence has to be evaluated and areas of uncertainty identified. Further research may be necessary to remove some of these uncertainties, but a point is reached when further delay would be procrastination and a rational framework for policy decisions is therefore needed. The precise timing of this transition from research-evaluation to decision-making depends on the assessment of risk. The more difficult it becomes to reverse the potential causes of harm and the greater the apparent risk, the more prudence dictates the need for policy decisions even when significant uncertainty remains. The assessment of risk has to be based both on the statistical estimate of its magnitude and on public attitudes to it. We explore the implications of risk in this chapter.

2.2 Policy decisions have to be based on a comparative evaluation of the benefits of the policy, the reduction or elimination of the risk, and the costs. Costs, and some benefits, can often be expressed in monetary terms, but attempting similarly to evaluate all kinds of benefit (for example the survival of a rare animal) is difficult and regarded by some as ridiculous(15). A more straightforward approach, therefore, is to predetermine, not necessarily on economic grounds, a maximum 'acceptable' level of risk, and then to formulate a policy which will secure this level at lowest social cost. However, the lower the costs, the stronger becomes the case for taking policy decisions, even though some uncertainties may remain in the scientific evidence, since the penalty for adopting a policy which subsequently proves to be wrong or unnecessary will be correspondingly lower. Thus determination of the acceptable level of risk cannot necessarily be divorced from considerations of cost, although certain types of hazard may be thought to call for action regardless of cost. As we argue elsewhere (paragraphs 6.40-6.42), pollution abatement costs are reduced if policy decisions are consistently framed against a medium- to long-term timescale. This planned approach to pollution control, which we emphasise throughout the report, permits a more sensitive evaluation of risks and eases the transition to decision-making.

Public attitudes to pollution

2.3 As we have mentioned in Chapter I, we thought it important to get a broad picture—however impressionistic—of the main problems of environmental pollution which people tend to worry or complain about today.

We summarise in Table 2.1 the major topics raised in the evidence we received from the large number of organisations, official and independent, that responded to our initial invitation of December 1981. The Table also takes account of issues raised in discussions we had with environmental groups on our subsequent visit to north east England. We recognise that our invitation for evidence (reproduced in Appendix 3) did draw attention to certain broad issues and that this may have influenced the responses; therefore not too much emphasis should be placed on the ranking of the various items in the Table.

2.4 It is interesting to compare the priorities indicated by Table 2.1 with the conclusions of an international conference organised in November 1982 by the Royal Swedish Academy of Sciences in Rättvik, Sweden, to mark the tenth anniversary of the United Nations Stockholm Conference on the Human Environment(26). This conference brought together over 30 scientists from leading research institutions concerned with a wide range of environmental problems in Brazil, Canada, Federal Republic of Germany, India, Kenya, Poland, Puerto Rico, Sri Lanka, Sweden, Switzerland, Thailand, Tunisia, the Union of Soviet Socialist Republics, the United Kingdom and the United States of America. Participants were invited to consider three key questions:

(i) What environmental problems are inadequately understood and urgently require intensive scientific research?

(ii) What problems are well understood on a scientific basis but urgently require new management efforts?

(iii) What are the priorities among these problems for both environmental research and management in the 1980s?

Table 2.2 sets out the conference's conclusions on the ten most urgent issues requiring further research and on the ten issues where participants saw the most urgent need for policy decisions on appropriate management measures. (Within the two categories no ranking in order of priority was attempted.) Leaving aside the issues which are not directly relevant to Europe and those which relate primarily to wildlife conservation, there is a fairly striking concurrence with the problems emphasised in Table 2.1.

2.5 Of the issues listed in Table 2.1, noise is a problem that causes much concern to the private individual. We understand that it is the most frequent cause of complaint to local authority environmental health departments, and this is borne out by the frequency with which it was cited in the evidence to us. We were interested to note that surveys of public opinion in Japan have placed noise highest among pollution problems about which there is general concern(27). Noise can disrupt human activities and make the environment unpleasant for large numbers of people, but it has virtually no lasting effects on the physical environment or on wildlife. In this respect noise stands apart from most other environmental problems (see paragraph 6.16). Many of the issues in Table 2.1 are ones that have been before the Commission since its inception: what is new is the increasingly international nature of the problems most frequently put to us. This raises questions of common standards of control and of international measures to deal with the transfrontier movement of pollutants.

TABLE 2.1

Environmental issues raised more than once in oral or written evidence to the Commission in 1982

Most Frequent	Air pollution, including carbon dioxide, sulphur oxides and motor vehicle emissions
	European Community directives and action programmes and United Kingdom stance
	Heavy metals, especially lead
	Inaccessibility of information; confidentiality
	Noise
	Waste and toxic materials
	Water pollution and sewage
Frequent	Derelict and contaminated land
	Energy and the environment
	Impact of economic conditions on pollution abatement
	Litter
	Nuclear power and waste disposal
	Pesticides
	Risk assessment
	Straw burning
Occasional	Indoor pollution
	Oil at sea
	Opencast mining
	Population growth
	Visual pollution

TABLE 2.2

Conclusions on environmental priorities reached at the Rättvik Conference 1982

Research Priorities	Acid deposition
	Carbon dioxide build-up and climatic change
	Cryptic spread of mutant genes
	Depletion of tropical rain forests
	Droughts and floods
	Energy needs
	Impact of hazardous substances
	Reduction of biological diversity
	Salination
	Urbanisation
Management Priorities	Acid deposition
	Control of pathogens from human waste and their aquatic vectors
	Depletion of tropical rain forests
	Desertification due to overgrazing
	Fuel wood crisis
	Management of hazardous chemicals, processes and wastes
	Population growth and urbanisation
	Protection of the marine environment
	River basin management
	Species loss

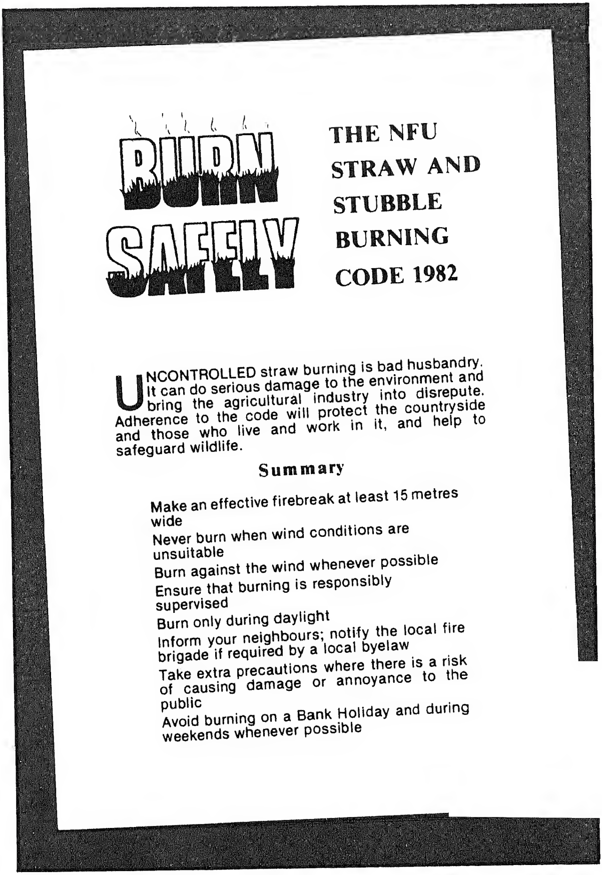
Source: Reference (26).

Some areas of recent particular concern

2.6 Public concern is often heightened by particular incidents and the consequent publicity. Whilst we have been completing our report two particular issues have received widespread coverage and we comment on them briefly as they raise questions of cost, timescale and the assessment of risk in dramatically contrasting ways. Both of them have received attention in earlier reports by the Commission.

2.7 The first of these issues is the practice of burning straw on stubble fields after the harvesting of cereal crops. This has become a matter of widespread concern and illustrates a number of general aspects of pollution control. Increased arable acreage and declining numbers of mixed farms with livestock, together with changes in agronomic practices, have tended to favour burning on the field as the preferred method in the United Kingdom of disposing of surplus straw. The practice was frequently referred to in the evidence we received in 1982, much of it suggesting that existing safeguards, which had received qualified approval from the Commission in the Seventh Report(5), needed to be tightened. Subsequently, as a result of weather conditions in the summer of 1983, public feeling against straw burning became particularly strong and complaints about effects on health, the environment and amenity received considerable publicity. On the whole, the ill-effects of straw burning are tangible and immediate; no estimation of risks from consequential effects is involved.

2.8 In 1983 most of the public complaints about straw burning related to the deposition of smuts from the incomplete combustion of the straw. A dense, irritant smoke can be produced (Plate 1) but relatively little is known about its chemical composition. A recent study has estimated that between 1.4 and 5.9 kg of suspended particles (smuts) are produced from burning one hectare of straw on stubble, and that aldehydes are the most important gaseous pollutant, with from 0.2 to 2.3 kg produced from one hectare(28). The effects in 1983 were many and varied. There were numerous reports in national and local newspapers of damage to horticultural crops, of losses to industries ranging from printing to blanket making and of disruption of activities in schools and hospitals. Houses and their contents were blackened by smuts, many people suffered extreme annoyance, and in some cases it was claimed that harm to health had been caused by exposure to smoke and ash. Injuries and even deaths occurred when reduced visibility caused road accidents. On many occasions fires burned out of control, damaging or destroying hedgerows and wildlife, and stretching the resources of fire brigades. Most of these effects will have resulted in some financial loss to the individual or the community. Unlike the putative effects of low-level, cumulative pollution, the impact of straw burning is immediate; yet it is often impracticable for the individual to contemplate suing a farmer for damages, since the precise origins of the smoke and ash particles may be difficult to prove in court.



BURN SAFELY

THE NFU STRAW AND STUBBLE BURNING CODE 1982

UNCONTROLLED straw burning is bad husbandry. It can do serious damage to the environment and bring the agricultural industry into disrepute. Adherence to the code will protect the countryside and those who live and work in it, and help to safeguard wildlife.

Summary

Make an effective firebreak at least 15 metres wide
Never burn when wind conditions are unsuitable
Burn against the wind whenever possible
Ensure that burning is responsibly supervised
Burn only during daylight
Inform your neighbours; notify the local fire brigade if required by a local byelaw
Take extra precautions where there is a risk of causing damage or annoyance to the public
Avoid burning on a Bank Holiday and during weekends whenever possible

2.9 In economic terms, the costs of straw burning are largely externalised. The Commission's Seventh Report(5) pointed out in this connection that compared to other industries 'agriculture is in a privileged position in the matter of straw burning' (paragraph 5.71 of that Report). Many of the objectionable incidents in 1983 evidently arose because farmers did not adhere properly to the National Farmers' Union 'Straw and Stubble Burning Code'(29) (see box on previous page). As a result, the NFU has plans for tightening the Code before the 1984 harvest. In parallel to this, the Minister of Agriculture, Fisheries and Food has announced that his Department and the Home Office will be considering ways of strengthening the model byelaw which many local authorities have followed when introducing byelaws to control straw burning in their areas(30).

2.10 The Minister's announcement, however, rejected the possibility of an outright ban on straw burning for the foreseeable future. Whilst there are many potential alternative uses for straw(31,32) (see box below), most of the methods involved require further research and development before they can become economic and practical alternatives to straw burning. The scope for further reductions in the straw yield of cereal crops, for instance by plant breeding, will also depend on continuing research. Not unreasonably, the agricultural industry is reluctant to invest in new developments for which a demand is not assured; it will always be easier (and probably cheaper) for the farmer to dispose of straw by burning.

POTENTIAL USES OF STRAW

'Is there any other commodity which has so many applications, so many possibilities and yet at present is so useless? So useless that it has to be destroyed. And its destruction is in itself totally wasteful and an offence to the environment and the neighbours alike. The sad fact is that until alternative uses are found straw has to be burnt and . . . there is no alternative.' (The Earl Ferrers, Minister of State, Ministry of Agriculture, Fisheries and Food, in a speech opening the Agricultural Development and Advisory Service's Sixth Straw Utilisation Conference, November 1982)(31).

Animal bedding	
Animal feed	—direct
	—after chemical treatment, including the use of silage effluent
Energy source	—on farm for hay and grain drying
	—domestic and greenhouse fuel (pellets)
	—industrial, e.g. cement manufacture
Raw material	—paper production
	—board production, e.g. Stramit, Polpaille
	—box production
	—traditional uses
Soil conditioner	—chopping and incorporating into the soil

2.11 Exceptional though the events of 1983 may have been, they have helped to draw attention to a form of pollution which we believe calls for more reliable methods of control if it is not to become a regular problem. Straw burning is an example of a pollution problem which needs to be tackled with carefully planned measures, in accordance with a firm timetable announced well in advance. We therefore **recommend** that the Government should announce the introduction of a legislative ban on straw burning on stubble fields to take effect in five years' time; the legislation should be introduced now and come into effect on the prescribed date without the need for subsequent statutory instruments or commencement orders (see paragraph 3.50). Similar proposals have been made by bodies such as the Countryside Commission and the National Society for Clean Air. Once there is this assurance that the practice will have to be discontinued the industries concerned will be able to make the necessary investment to develop ways for the profitable use of the surplus straw (an example of the concept of technology forcing, which United States and Japanese regulatory authorities claim to follow). At the same time, continued safeguards and improved handling methods will be needed to reduce the risk of accidental fires while straw is awaiting disposal after harvest. Since the problem is not confined to the United Kingdom (we understand that local regulations effectively preventing the practice are in force in a number of European countries), the appropriate technology might have export potential, provided the United Kingdom is among the leaders (see paragraphs 6.23-6.27). In this connection we note that, notwithstanding the early recognition of the problem in Britain and the potential of straw as a energy source, about half the papers on this aspect delivered at the 1982 ADAS Conference (see box opposite) were from overseas. We **recommend** that the Ministry of Agriculture, Fisheries and Food and the Agricultural and Food Research Council should give greater priority to research and development on alternative uses of straw in the immediate future.

2.12 The other issue which needs to be mentioned here is the discharge into the sea of certain wastes arising from the nuclear fuel reprocessing plant at Sellafield (formerly Windscale). The management of these wastes was discussed by the Commission in its Sixth Report(4) and has since been kept under review by the Radioactive Waste Management Advisory Committee (RWMAC)(33), which we discuss in paragraphs 3.42-3.44. For some time there has been public concern, accentuated by recent events, about radioactive wastes which build up in the Irish Sea or are transported by marine currents to the North Sea (see paragraph 4.88 and Figure 4.5). Concern has also been expressed about dust contaminated by radioactive wastes, especially in houses near the plant. Dust can become contaminated by gaseous emissions or by radioactive material originally discharged to the sea but subsequently remobilised from dry sediments or sea spray.

2.13 The Sellafield discharges illustrate a number of general problems—the potential hazards from long-term accumulation of pollutants (see paragraphs 1.12 and 3.26); the difficulties of assessing risks when the effects are not immediate; the danger of creating irreversible pollution in the future (see paragraphs 6.12 and 6.19); the public's particular anxiety about cancer; the real or supposed difficulties of obtaining public information (paragraph 2.33 *et seq*.); and the timing and cost of investment which may have major implications for an important national industry (paragraph 6.29 *et seq*.).

2.14 In view of the activities of RWMAC (which was set up as a consequence of the recommendations of the Sixth Report), we decided when embarking on the present study not to call for evidence specific to this field; and in the absence of such evidence (which would take time to assemble and evaluate) it would not be appropriate for us to offer a considered judgment on these complex matters, which are the subject of continuing scrutiny by both RWMAC and the National Radiological Protection Board. We shall, however, keep them under close review.*

Measured risks and perceived risks

2.15 As individuals and societies we are exposed to hazards† at all times: from natural events such as floods or lightning, from disease, from accidents in the home, the workplace or on the roads, and from substances introduced into the environment by man. Pollution may by definition be regarded as a hazard, because of the potential or actual harm it causes (see paragraphs 1.10–1.12). However, the harm to man or society may result from damage to the environment or amenity rather than directly to health. Therefore, exposure of man or the environment to a pollutant necessarily carries a risk of harm of some sort. No human activity is without risk, but it is evident that the risks associated with some activities are less acceptable than others. Pollution problems, such as those associated with lead, asbestos, the handling and transport of radioactive materials, and the use of certain agricultural chemicals, are increasingly being seen by the public to pose risks which are unacceptable, despite the fact that activities with risks which are mathematically at least as great, if not greater, are considered to be more acceptable. The activities of pressure groups and the amplifying effect of the media have done much to bring about this growth of concern about pollution.

2.16 The subject of risk has recently been considered by a Royal Society Study Group(35). The Group examined, among other things, risk assessment as an aid to decision-making and the psychology of risk perception.

2.17 Quantitative risk assessment has been the subject of study for many years and a number of techniques have been developed. For a particular hazard the risk of specified damage can often be expressed in mathematical terms. The data, which may be neither very precise nor very accurate, are obtained in a number of ways. For example, the risk of wildlife mortality from an accidental spill of pesticide into a river may be estimated from laboratory studies of toxicity; the risk to man of carbon monoxide poisoning in the home may be calculated from medical statistics; and the risk of release of a poisonous chemical from a new, untried industrial process may be estimated by sophisticated methods of identifying and quantifying engineering risks. It is thus possible to provide estimates of the comparative risks of participating in various activities: as an illustration of the results of such calculations, Table 2.3 shows the relative risks of death from various forms of travel.

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*Shortly after we signed this Report the Government announced that it had commissioned an independent review of the medical evidence for an apparent cluster of cancer cases in the village of Seascale close to the Sellafield site(34).

†Different terminologies have been used by different authors, and colloquially, on the subject of risk assessment. Here, and elsewhere in this Report, we follow the broad definitions of the Royal Society Study Group(35).

TABLE 2.3

Numerical estimates of risks of death from various forms of travel

Numbers are in deaths per 10^9 km travelled and are based on data for 1972–1976	
Rail travel	
To passengers, from train accidents	0.45
Air travel	
UK airlines, passengers on scheduled services	1.4
Road travel	
Public service vehicles, passenger or driver	1.2
Driver of goods vehicle	
of 1.5 tons or less	6
of over 1.5 tons	5
Car or taxi	
driver	8
passenger	7
Pedal cyclist	85
Two wheeled motor vehicle	
driver	165
passenger	359

Source: Reference(35).

2.18 Interest in public perception of risk as a subject for study is of more recent origin. Perceived risk is a combined evaluation of the likelihood of an adverse event and the nature of the consequences. Members of the public often have a different perception of the adverse event than do experts using objective methods of risk estimation such as those described above. In such cases there may be a tendency to dismiss the public perception as irrational, but the Royal Society Study Group cautioned against such an approach and drew attention to a number of reasons to explain the differences.

2.19 Objective estimation of risk is often able to deal only with human mortality, while public perception of an adverse event can take into account wider consequences such as morbidity, harm to wildlife and loss of amenity. A striking example is the public perception of the risk of lead poisoning in children(7). Estimations of the risk of lead poisoning can be made from data on the few mortalities and on records of diagnosed cases of frank lead intoxication. The public perception, however, is more of a risk (whether or not the risk is real) of impairment by lead of a child's intelligence, behaviour and performance. Research has shown that public perception of risk bears very little relation to the degree of risk when expressed as a mathematical probability but depends on a variety of other factors such as whether the taking of risks is voluntary or involuntary, whether the hazards affect individuals or the whole of society, whether damage occurs in the short or long term, and whether the adverse event affects a small or a large number ('catastrophe') of people(35). It is also true to say that familiarity breeds contempt: the public takes for granted, or has come to live with, many hazards which, if introduced for the first time, would be regarded as quite unacceptable. The effect of some of these factors on the public perception of risk is illustrated in Figure 2.1, which is based on a study of eighteen risk characteristics of ninety hazards(36).

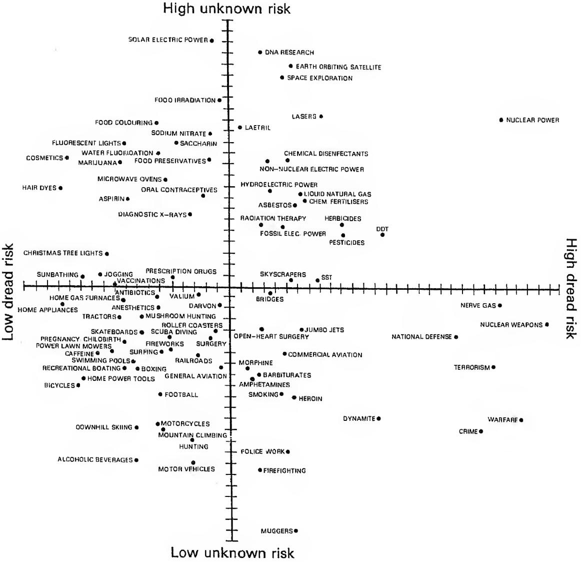

Figure 2.1
Comparison of risk perception of different hazards
Source: Reference (36).

Individual concern and public responsibility

2.20 Studies of risk estimation and risk perception help to illustrate the gap which often now separates the attitudes of the general public (or at least a substantial section of it) and the authorities. Sometimes this can result in a creative tension, which serves to dispel complacency among officials and encourages a less narrow approach by scientists. In other instances a real conflict emerges, with officialdom and public campaigns each occupying entrenched positions. The danger here is that political considerations become predominant, with the authorities reluctant to change their attitudes for fear of being seen to respond to pressure.

2.21 Lack of understanding of the process and limitations of scientific research is a cause of particular difficulty. The pollution issues which produce conflict are usually, by their very nature, those on which the scientific evidence is inconclusive or conflicting. Members of the public may become confused by, and disenchanted with, the contribution of scientists, particularly when individual scientists are shown by the media as articulate advocates for opposing sides.

2.22 Scientific research can provide a framework for decisions but it is not the only factor which helps to determine policy. The methodology of research, its results and the conclusions drawn are matters on which there may be disagreement, but they are nevertheless scientific matters and thus in principle capable of objective resolution. Assessing the wider social, economic and technological implications involves making more subjective judgments, of a managerial and possibly political nature, and thus may be a matter of some controversy.

2.23 Public opinion, where it can be reliably gauged, is another important factor to be taken into account. In forming its opinions the public is heavily influenced by what it learns from the media and other sources and by the ways in which the issues are presented. We have noticed a tendency in some areas for relatively small risks to become magnified and for the public to see major hazards where there is little evidence of potential damage. This does not mean that the strength of public opinion in these circumstances is not a valid reason for governments to take action, since that is a matter for political judgment.

2.24 As we discuss in Chapter III, part of the difficulty may stem from the constitution and operating methods of the various regulatory authorities and advisory bodies concerned. Other factors (which we discuss later in this chapter) are unnecessary secrecy and lack of openness, which lead to an atmosphere of mutual mistrust between the public, industry and the authorities. We have come across examples of this at first hand—the angling society unable to obtain straight answers from either the water authority or the textile firm about discolouration of the river; the local environmental group, concerned to discover the nature of some radioactive waste, being referred from one uncommunicative authority to another—and we have heard of many others.

2.25 Industry and pollution control authorities share a responsibility for seeing that the public is provided with facts and expert opinions on which to base a balanced judgment. But they must beware of adopting a 'we know best' posture. They must recognise that the public's subjective judgment, and even 'gut reaction', have an essential part to play. In a democracy it is an unhealthy sign when authority claims omniscience and dismisses grass-roots concern as 'irrational'. On the other hand, a similarly intolerant attitude on the part of the public and pressure groups is equally reprehensible if conditions exist for reasoned discussion.

Public pressure and the burden of proof

2.26 There is a long history of environmental groups in the United Kingdom mobilizing public opinion and trying to influence the authorities on particular issues(22). The phenomenon of professionally run 'campaigns', however, acting to achieve specific aims in a set time, is more recent. For these campaigns the end is usually more important than the means and issues tend to be presented to the public in black-and-white terms. The skill of environmental groups in obtaining effective publicity has greatly increased in recent years. It therefore has to be asked what are the consequences of a conditioning of public attitudes by publicity.

2.27 Many of the current pollution issues are characterised by scientific uncertainty about effects or causes and by pressure on government, usually by a vocal and well-organised section of the public, to take action before the outstanding scientific questions are answered. This leads to the question of the burden of proof of whether a substance presents a hazard and the related question of the risk of damage. Should a substance be regarded as innocent until proved guilty, or guilty until proved innocent? In fact both approaches can be seen in United Kingdom practice today.

2.28 In the past substances have tended to be treated as innocent until proved guilty. The benefits of a substance, or of a process producing hazardous substances as by-products, have usually been evident long before the hazards. There are innumerable substances synthesised by man or naturally occurring but introduced by man to man's environment which might be hazardous. It is quite unrealistic to suggest that all these substances should be considered suspect until thorough testing has given them a clean bill of health. Experience has shown that the vast majority of substances present either no detectable hazard or a risk so small as to be generally acceptable. Furthermore, we cannot predict the nature of all possible hazards and test for them. For example, only in the last decade has research been able to show that gaseous pollutants can affect crop yields without producing external symptoms of damage. Most substances are put to uses which are considered, for technical, economic or social reasons, to be essential, and if no longer used might need to be replaced by other substances presenting perhaps an equal or greater hazard.

2.29 On the other hand the United Kingdom has a number of regulations and voluntary schemes designed to protect man and the environment from the introduction of new substances which could present a hazard. (These are in addition to controls on substances which are known to cause damage.) For example, both medicines (Medicines Act 1968) and specified substances added to foods (Food and Drugs Act 1955) are subjected to a detailed safety evaluation before Ministers permit their use (see paragraph 2.64 on the arrangements for notification of data on other new chemical substances). The Pesticides Safety Precautions Scheme is a non-statutory scheme which is designed to protect users of pesticides, consumers, bystanders, domestic and farm animals, wildlife and the environment generally. The Royal Society Study Group on risk has pointed out that the tests needed under these regulations and schemes are expensive and that there is a shortage of manpower and resources to undertake them, and has proposed serious consideration of only 'limited testing' before authorising the temporary use of a substance for which a good case has been made(35).

2.30 It occasionally happens that a substance which has been in use for some time with no apparent harmful effects, or which has previously passed recognised safety screening tests, comes under suspicion in the light of new knowledge. In these circumstances there may be a conflict between the view that new controls should be introduced only in response to rigorous scientific proof of the alleged hazards and the view that sufficient evidence already exists for refusing clearance of the substance if a proposal for its use were being considered for the first time. Occasionally the even more extreme view is heard that if the substance is dangerous enough to warrant research it should be banned while this is going on. The counter-demand for 'scientific certainty' is, however, generally specious and may be put forward largely for tactical reasons. It was certainly present in much of the recent debate in this country about possible harmful effects of lead additives in petrol(7). The related argument, now familiar in European Community circles, that emissions or discharges should be regarded simply as 'contaminants' unless they can be demonstrated to have polluting (i.e. harmful) effects raises similar issues (see paragraphs 1.11-1.12 and 3.26).

2.31 It is sometimes said that governments, perhaps bowing unnecessarily to public pressure, over-react in relation to the scientific evidence. One example cited is the action taken by the European Community to control mercury pollution(37) (see paragraph 3.15). Nevertheless there can be circumstances in which it is sensible to regard the onus of proof as having shifted and for an environmental contaminant, hitherto believed to be harmless, to be treated for the time being as guilty until proved innocent. The main criterion for such a switch of approach should be that the scientific evidence is inconclusive and likely to remain so for some time, but with a significant probability of serious damage—particularly of persistent or cumulative damage of an irremediable nature (see paragraph 3.26). Other criteria should include genuine public concern, which deserves attention irrespective of its basis, and the strength of the economic or technical case for the substance's continued use. In the case of lead all of these criteria contributed to the main recommendations in our Ninth Report (7). We consider that there will be few instances where this switch of approach will be justified, but that the public should have the confidence that government will be prepared to change its attitude in circumstances short of rigorous scientific proof of damage.

2.32 Environmental regulation is thus not simply an issue of scientific facts, and it is a delusion to imagine that decisions, even in a ideal world, could ever be based on complete impartiality and objectivity. We expect government to behave like a manager, not a scientific referee (see paragraph 6.30). This involves weighing up all the issues, both scientific and non-scientific, and arriving at reasonable judgments on the predictions which it would be prudent to adopt and on the action which should, in consequence, be taken. Rigorous scientific 'proof' should therefore not be regarded as a *sine qua non*. Even an element of sheer expediency is not always to be condemned. As a recent commentator on the question of low levels of lead and their possible effects on children's intelligence has said:

> 'The things we would like to know may be unknowable, so there is some virtue in just getting rid of the problem'(38).

CONFIDENTIALITY

Introduction

2.33 Over the years the Royal Commission has repeatedly pressed for unnecessary secrecy to be reduced. In the Second Report, published under Lord Ashby's chairmanship in March 1972(39), the Commission referred to the widespread insistence by industry, river authorities and local authorities on maintaining confidentiality over the types and amounts of industrial wastes discharged to land, air, sea and rivers, and commented:

> 'We doubt some of the reasons for this confidentiality and our doubts are shared by many of the witnesses from industry with whom we have spoken. It is a practice which on occasion hinders the flow of information needed by responsible people concerned with the abatement of pollution and it leads to risks of misunderstanding on the part of the public which may be harmful to industry and Government alike.'

The Commission's conclusion was that the problem

> 'needs to be considered urgently, and on an industry-wide basis, bearing particularly in mind:
>
> (a) the need for an increased flow of information to persons of responsibility who can use it for the ultimate benefit of the environment, for example, Members of Parliament, research workers in universities and persons with similar interests in pollution; and
>
> (b) the problem of how protection can be secured in those cases, which we suspect to be comparatively rare, where genuine industrial or trade secrets are involved.'

2.34 In its Third Report, of September 1972(40), the Commission recommended that these considerations should apply to the new arrangements proposed for controlling pollution in estuaries and coastal waters. In response to the Commission's advice and to advice received shortly afterwards from the Clean Air Council(41), new measures were enacted in the Control of Pollution Act 1974 which provided for public disclosure of information about waste disposal to land, discharges to rivers, estuaries and coastal waters, and emissions to the atmosphere. Provision was made, however, in the Act (or, in the case of land disposal, in subsequent regulations) for the protection of trade secrets, and in the case of atmospheric emissions disclosure of information was to be at the discretion of local authorities. Whilst welcoming the new measures, the Commission, now under the chairmanship of Lord Flowers, stressed the need for them to be exercised in accordance with the principle 'that there should be the fullest possible disclosure about waste discharged to the environment'(2). As we note in the next two chapters, the provisions relating to liquid discharges are not yet in force and are currently being implemented over an extended timetable.

2.35 At the beginning of 1976, in the Fifth Report(3), the Commission recommended a number of ways in which disclosure of information about air pollution could be made fuller and more effective (see paragraphs 2.58–2.62) and in the Sixth Report, published later that year(4), the principle of open and informed debate, as opposed to 'bland, unsubstantiated official assurance', was implicit throughout the Commission's recommendations on nuclear power. The Commission's most recent statement on the issue, under Sir Hans Kornberg's chairmanship, came in the Seventh Report, on Agriculture and Pollution(5), published in September 1979 (see paragraphs 3.48 and 3.53). Referring to the non-statutory Pesticides Safety Precautions Scheme, it recognised the need for at least some of the information provided by pesticide manufacturers to remain confidential for commercial reasons. Nevertheless the Commission recommended that data on pesticide manufacture and sales, including details of active ingredients, should be made freely available and published (a recommendation which is paralleled by a recommendation in our Ninth Report (7) relating to data on leaded paint). The Commission also noted that it had received evidence that research workers were being hindered in their scientific work by confidentiality being carried to unnecessary lengths, and commented:

> 'We think that refusal to release information on grounds of confidentiality tends to become a reflex action, without specific reference to the question of whether commercial interests are truly at risk.'

2.36 Since this view has been consistently held and re-affirmed by successive Commission memberships, we decided that an important element in our general review of recent developments should be to assess how far the Commission's view remained relevant in present conditions and how far the intentions behind the Control of Pollution Act and other government initiatives have been fulfilled in practice. To this end the question of confidentiality was one of the specific issues on which we sought written comments from a wide range of witnesses, and it also featured prominently in the discussions we held with, among others, the Confederation of British Industry (CBI), the Industrial Air Pollution Inspectorate (formerly Alkali and Clean Air Inspectorate) and representatives of the water industry. These discussions took place against the background of continuing, if not increasing, concern among environmental groups and others(42) about excessive official secrecy, with a new freedom of information campaign due to be launched early in 1984.

The current attitude of industry to disclosure of information

2.37 In its written evidence to us, the CBI included the following statement:

> 'The test of the success of pollution control practices and policies is to see whether the quality of the environment sought has been achieved by requirements which apply. The public "needs to know" whether or not the quality standards in any particular area of the environment are being maintained or infringed. Thus we accept that the results of environmental monitoring are of prime concern to the public and should be openly available, as provided in the 1974 Act. Also the public are entitled to know what pollution control requirements apply and when and in what circumstances they are breached; in these cases there may need to be some disclosure about an emission's content.
>
> 'General disclosure of data about the content of discharges to the environment causes industry concern because it could involve highly-sensitive data which may be of commercial advantage to a competitor. Such data are first and foremost the property of the discharger and their disclosure should not be expected or demanded without good reason. In practice industry often discloses information which relates to the quality of the environment, as a responsible neighbour and part of society; but this disclosure cannot be assumed to be a public right nor refusal to disclose taken to mean there is "something to hide". On the contrary, it normally means that the firm believes it right to keep to itself its own property of which the disclosure could damage it commercially.'

2.38 The CBI's evidence also drew our attention to a policy statement of 1979 on the release of environmental and technical information(43), in which the following passage appears:

> 'Greater release of data enhances the risk of their misinterpretation and the likelihood of unwarranted alarm or ill-founded "remedial" actions . . . Data are often highly detailed and technical, requiring interpretation by trained toxicologists; hence the capacity for correct interpretation is limited. This restricts further the amount and type of information which can usefully be released without problems of misinterpretation.

> 'Information disclosed should be meaningful to the recipient. For example under UK health and safety legislation the information which inspectors and employers are required to pass to employees or trade unions should be in terms of precautionary notices or labels rather than of product composition.
>
> 'The threat of legal proceedings will be enhanced by increasing disclosure of data. Applications for injunctions at common law could become more likely, putting industry at greater risk of additional costs and penalties even when it satisfies the requirements of the competent control authorities.'

2.39 Some similar sentiments are to be found in a statement submitted to us by Imperial Chemical Industries plc:

> 'We hope that the regulatory authorities and industry will work together, within the spirit of COPA II*, to resolve any outstanding probems and maintain the quality of the environment at an acceptable level. If, following publication of consent data, COPA II is misused and becomes a charter to prevent contaminating (i.e. harmless) discharges rather than polluting (i.e. harmful) levels, industry would be faced with considerable expenditure . . . Industry accepts its responsibility to assess possible hazards by studying the concentration, degradability, bio-accumulation and toxicity and to share this information with an authority before a new consent is applied. Free access to this information by the public leads to pressure for tighter and tighter consents and to the loss of the confidential working relationship with the authorities that we value.'

2.40 These statements by industry and other evidence we have received illustrate a number of different aspects of the problem, which we discuss below:

(a) Trade secrets
(b) The public's competence to interpret environmental data; the danger of misrepresentation and vexatious litigation
(c) Administrative costs
(d) 'Environmental rights'
(e) The effect of secrecy on risk perception
(f) Auditing of pollution control authorities.

Of these, aspects (a)-(c) tend to be cited in support of confidentiality, with (d)-(f) cited as reasons for disclosure.

Trade secrets

2.41 The CBI attaches great importance to the principle that data disclosed to regulatory authorities remain the private property of the firm concerned. The owner of data is entitled to have a say in what data are to be disclosed, in how it is done and to whom; he should also have a residual right, if disclosure seems likely to affect adversely his interests, to keep data confidential to himself or to require an authorised recipient to keep them confidential. As a general principle, therefore, the CBI takes the view that individual companies should be entitled to keep information to themselves unless there are overriding reasons of public interest to justify its disclosure.

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*Control of Pollution Act 1974, Part II.

2.42 The main way in which the interests of the firm could be adversely affected would be through the disclosure of trade secrets. In its evidence to us, the CBI confirmed that it is possible in certain circumstances for commercially-sensitive information about a product or production process (for example the type of catalyst used or the formulation of a complex composite material) to be deduced from knowledge of an effluent's content. Since the precise nature of a catalyst may not be patentable, process information of this kind may be particularly valuable to a competitor. Analysis of a product, even by the most sophisticated techniques, would not necessarily indicate the method by which it had been made, and effluent composition data could therefore provide useful further clues. It was not only from the composition of effluents but also from their volume, and the variation in their volume and composition over time, that information about the nature and efficiency of a process and the production of a company might be deduced. Even the mere knowledge that a discharge was being made at all could be valuable.

2.43 In practice incidents in which companies have obtained valuable information about a competitor from the records of an environmental regulatory agency appear to be very few, notwithstanding the greater accessibility of such information in many countries such as the United States of America and Canada. Apart from the now notorious case of the inadvertent disclosure by the US Environmental Protection Agency of the formula of a successful Monsanto weedkiller, a team from the CBI knew of only one relevant example.

2.44 Modern techniques of chemical analysis are such that it would be a relatively simple matter for a competitor to discover the composition of an emission or discharge by taking a sample at the point where it left private premises. It would be less easy to obtain information, by direct sampling, on variations in emission or discharge volume and composition, which might be of more value to a competitor. In practice information of this kind would not normally be contained in sufficient detail, if at all, in officially-held records.

2.45 We therefore conclude that only on exceptional occasions would therwise inaccessible trade secrets be revealed from the information that egulatory authorities are entitled to receive by statute. This onclusion—which closely accords with that in the Second Report(39)—is idely shared by the water industry. The comment of one water authority was: In our experience there are few valid examples where it is necessary to withhold information on the water quality of discharges in order to protect the legitimate interests of industry'(44). Another has expressed the hope that the use of the Secretary of State's power to grant exemption from publicity under Section 42 of the Act 'will be exercised only in those cases where avoidance of publicity is needed for genuine trade secret purposes and reasons of national security'(45). We share that hope, and believe that the philosophy embodied in Part II of the Act, where the onus is on the polluter to prove the need for confidentiality, will help to ensure that it is fulfilled as far as water pollution is concerned.

The public's competence to interpret environmental data; the danger of misrepresentation and vexatious litigation

2.46 In the Fifth Report(3) the comment was made that 'we are dealing with an increasingly educated public, one which increasingly wishes to form its own judgment on the basis of the facts and which increasingly resents official supposition that it is incapable of doing so'. Nevertheless a common attitude in some quarters is that the demand for more information about the quality of the environment has been artificially stimulated by pressure groups and that 'the public' not only lacks interest or competence to interpret the data but has no real 'need to know'. As a recent commentator(46) has put it:

> 'Another common objection to disclosure is the suggestion that technical information will be deliberately distorted by alleged extremists, or misinterpreted by the well-intentioned. In practice, anyone who believes that the public should be warned—or frightened—about the hazards of pollution can raise the alarm quite effectively without the help of specific data . . . In fact, those who would really make use of the detailed information at present so often withheld are the increasing numbers of individuals and organisations who have the ability to understand the technical issues involved and can assess for themselves the adequacy of the decisions taken in their name.'

2.47 We agree; and whilst we do not necessarily see all pollution issues in the clear-cut terms in which it is in the nature of pressure groups to present them, we have seen much evidence of a growing professionalism in many voluntary organisations in the environmental field and with it an ability to evaluate and present technical and scientific reports which compare favourably with those of officially sponsored researchers. In our view, to deny access to data on the grounds that 'the public' is not competent to make 'correct' use of them is neither a tenable nor an acceptable position. At the same time we recognise that occasionally data may be genuinely unintelligible to even an expert outsider without interpretation by those responsible for their collection.

2.48 The CBI has also referred to the danger of vexatious litigation. We would merely make the comment that it is the duty of the courts to recognise vexatious causes and not to grant injunctions where the complaint is plainly without merit. We have no reason to suppose that the courts will fail in their duty.

Administrative costs

2.49 The view is frequently expressed, for instance in evidence to us by water authorities, that a wider requirement for open access to pollution control data might create a bureaucratic burden with little tangible benefit, because of the low level of public interest. Certainly experience in the local government field has shown that 'public participation'—often consisting of little more than the one-way provision of information at meagrely attended public meetings—can be an unrewarding ritual for those charged with the task of organising it. However, the essential requirement is that information should be *available,* not that it should be forcibly fed to the public. We note that the Control of Pollution Act, the relevant regulations made under it (SI 1976, No. 732; SI 1977, No. 19) and the proposed arrangements for implementation of Part II of the Act (see paragraph 4.32 *et seq*.) allow waste disposal authorities, water authorities and local authorities discretion over the form of the registers in which they keep details of licences, consents and other information. If the requirement to allow public access is taken account of in designing the method by which records are compiled, and if best use is made of modern information technology, we see no reason why reasonable public access cannot be maintained without incurring burdensome administrative costs.

'Environmental rights'

2.50 In its Second Report(39) the Commission stated that the public had an interest in the waters and other media into which pollutants were discharged, and commented:

> 'Firms which insist on secrecy without due reason . . . are vulnerable to the criticism that they are putting undisclosed and possibly dangerous wastes into an environment which belongs to the community.'

A similar view has been expressed by the House of Lords Select Committee on the European Communities in its recent report 'The Polluter Pays Principle'(47), which concluded:

> 'It should no longer be assumed by industry that free use of the environment as a sink should be permitted as a right.'

2.51 We endorse these sentiments. The public must be considered to have a right, analogous to a beneficial interest, in the condition of the air and water and to be able to obtain information on how far they are being degraded.

The effect of secrecy on risk perception

2.52 Secrecy—particularly the half-kept secret—fuels fear. In our visits and discussions we have noted instances where quite unnecessary concern has been caused by people's inability to obtain information on the nature of a discharge or waste material. As the Second Report put it:

> 'Since many industries are going to great trouble and expense to abate pollution, they do themselves a disservice by needless secrecy. We believe that public confidence in the concern these industries have for the environment would be strengthened if this needless cloak of secrecy were withdrawn.'

A similar point was put to us by a water authority(48):

> 'The free access of the public to information relating to discharges will . . . be of long-term benefit. Once any initial excitement has died down then the general absence of confidentiality and the general availability of information should allay public fears and diminish criticism.'

Auditing of pollution control authorities

2.53 We note that the CBI, in the written evidence quoted in paragraph 2.37, does not dissent from the proposition that the public has a right to know what standards have been set and whether they are being complied with. Since however many of the standards set in this country are a matter of negotiation between industry and the authorities (see Chapter III), in the absence of detailed information about consents and monitoring it is necessary for the public to take a great deal on trust. We recognise ICI's concern (paragraph 2.39) that greater public access to information might generate pressures for tighter controls: we do not however consider this—nor the fact that pressure groups might take an interest—to be sufficient grounds for secrecy.

The present position: moves towards greater openness

2.54 Although our comments on the formally stated position of industry may suggest that little has changed since the Commission's Second Report, there have in fact been a number of moves in the direction of greater openness—some of them autonomous, others stimulated by external requirements. For one thing, the climate of opinion has changed. There is a growing acceptance on the part of industry and pollution control authorities of the need to share information with the public. Positive initiatives have been taken by a number of companies to establish regular liaison arrangements with local authorities and the general public. We are pleased to note that in a recent policy statement(49) the CBI has emphasised the importance of promoting better understanding of industry's contribution to environmental improvement. Industry, the statement says, 'has been slow to respond or, still less, raise environmental matters publicly. In the absence of public comment from industry, accusations, however unjustified or false, have on occasions been accepted by default'. We welcome the CBI's statement and the increasingly enlightened attitudes which it reflects.

2.55 The public, for its part, as a result of growing interest by pressure groups and the media, is increasingly better informed on pollution issues. The sanctity of official data has become increasingly open to challenge. Authorities are expected to be more accountable, and the public is less willing to take things on trust.

2.56 In this context the need for openness is greater than ever and we therefore regret that, on present plans, the register provisions of Part II of the Control of Pollution Act will not become operative until mid–1985 (see paragraph 4.32 *et seq.*). The need is reinforced by international factors, in particular membership of the European Community. Not only does information increasingly have to be shared among Member States (as under the Chemicals Notification Scheme), but the United Kingdom's preference for the environmental quality approach to the control of emissions and discharges (see Chapter III) tends to create a demand for open evidence that the prescribed quality standards are being achieved. These factors are accepted, to varying degrees, by industry (see paragraph 2.37); we note too that there has been much spontaneous movement towards greater openness on the part of pollution control authorities. We consider briefly some of the main changes which have occurred.

2.57 In the water pollution field, several water authorities have been to some extent anticipating the requirements of Part II of the Act by publishing or otherwise making available details of discharge consents and of their water quality monitoring. Individual firms are asked to give permission for these details to be published and the majority do so (the number of firms who refuse is stated but the firms are not named). In addition many authorities in England and Wales have not sought to withhold information on the quality of discharges from their own sewage works even where there is room for improvement. The majority of Regional Water Authorities and River Purification Boards have stated explicitly in their evidence to us that they see no problems arising when the full provisions of the Act are in force. We note, however, that whilst section 41 indicates the broad categories of information that are to be contained in the public registers (see paragraph 4.31), the precise details are for the Secretary of State to prescribe. Since publication of any information not thus prescribed will be prohibited by section 12 of the Rivers (Prevention of Pollution) Act 1961, which remains in force, the usefulness of the registers may depend to some extent on the spirit in which section 41 of the 1974 Act is implemented. The Government has yet to initiate detailed consultations on this section, and in this connection we would endorse the comments made in the Commission's Fourth Report, quoted in paragraph 2.34 above.

2.58 In the air pollution field, we note that a great deal more information is now available, particularly from the Industrial Air Pollution Inspectorate (IAPI), compared with the position at the time of the Fifth Report, nearly eight years ago. For instance, IAPI has been actively encouraging the establishment of local liaison committees to discuss problems relating to registered works(50), and now provides local authorities with details of the 'best practicable means' requirements for individual works(24). Moreover, the annual reports of each District Inspector are now made available to local authorities, the management of major works, and interested members of the public(50). In its response to the Fifth Report the Government has stated(24) that 'HSE are intent on improving the flow of information about what they are requiring' and that 'the Government believe that the objectives of the Royal Commission's proposals can thus be met without sacrificing the valuable flexibility of the present system'.

2.59 Whilst we agree that most of the earlier grounds for criticism have in practice been removed, we nevertheless regret that these changes (welcome though they are) may have provided an opportunity for some of the Commission's detailed recommendations to be set aside without, it appears, a full examination of their merits. First, we remain of the view that it is wrong in principle that there should be an unqualified statutory prohibition on IAPI (in common with other 'enforcing authorities'), under section 28(7) of the Health and Safety at Work etc. Act 1974, from publishing details of emissions acquired in the performance of its duties except with a firm's consent. This contrasts with the powers exercised by local authorities under other legislation (notably section 287 of the Public Health Act 1936, section 26 of the Clean Air Act 1956 and section 94 of the Control of Pollution Act 1974), where the prohibition is confined to disclosure of 'trade secrets'. We accept that, as with water discharges, the firm should have the right to make representations, but we believe it should not be the final arbiter as to whether confidentiality is justified or not. The willingness of IAPI to pursue a far more open approach underlines the obsolescence of the present position, which perpetuates a presumption in favour of secrecy. In practice, we understand that the Inspectorate does not consider that section 28(7) places any significant restriction on their freedom to publish relevant data, although as a precaution against possible legal action it relies on overriding powers of the Health and Safety Executive when publishing information such as that contained in the District Inspectors' reports. Whilst this may overcome the legal problem, we nevertheless consider it unsatisfactory that IAPI should have to resort to this device because of an inappropriate provision in the Health and Safety at Work etc. Act. We understand that section 28(7) originated in legislation governing the Factory Inspectorate and analogous activities. It was never designed for environmental legislation.

2.60 Secondly, we feel the recommendation of the Fifth Report on public registers of air pollution control data should be explored further. We note that the Government rejects the Report's proposal that the present system whereby works are registered with IAPI should be replaced by the issuing of 'consents'. We do not agree, however, that this rejection need entail simultaneous rejection of the public register proposal. We believe it would make for much greater openness and accountability if details of the agreed 'best practicable means' for each works were available for public inspection, together with the results of emission tests and environmental monitoring. We also consider that these details should be combined with data collected by local authorities on 'non-registered' works. Thus it is possible to look forward to the day when the public will have access to information on all emissions to the atmosphere from industrial premises (see paragraph 2.62), on a common register and without distinction by control authority.

2.61 As far as local authorities' responsibilities in the air pollution field are concerned, we believe that even under existing legislation more active steps need to be taken to encourage the free exchange of information between industry, local authorities and the public. Local authorities themselves could do more to publicise the results of their pollution control activities generally, for example by making available the annual reports of their environmental health departments, as is already done by some authorities, such as

Birmingham and Manchester. The Institution of Environmental Health Officers has commented, in its evidence to us, that informal consultative arrangements seem to be more common than formal arrangements made under sections 79 and 80 of the Control of Pollution Act, which empower local authorities to collect and publish (with the firms' consent when trade secrets are involved) information about atmospheric pollution. Both the Institution and IAPI, in their evidence to us, have suggested that the provisions of sections 79 and 80 may be over-complicated and in need of reappraisal. On the other hand the CBI, in their 1979 policy statement([43]), called upon industry in a very positive way to co-operate with local authorities over these provisions. We believe there is some truth in the suggestion that the Government Circular which promulgated the relevant regulations in 1977 has had a dampening effect by emphasising the fact that the powers are discretionary and that local authorities must 'find the necessary resources from within their existing budgets'([51]). The Institution of Environmental Health Officers is aware of only five local authorities who have to date issued formal notices under section 80 requiring the disclosure of information, and of some 24 authorities who are known to have set up more or less formal consultative committees very few are believed to have done so in accordance with section 79([52]).

2.62 Many of the informal arrangements have however achieved considerable success in improving the flow of information at the local level. A notable example is the Coventry Pollution Panel, set up in 1970([53]). Nevertheless we endorse the views expressed in the Fifth Report that neither informal arrangements nor local authorities' discretionary use of sections 79 and 80 go far enough in guaranteeing to the public 'the right to know the state of the air they breathe and the amounts of pollution emitted by both registered and non-registered industry'([3]). We also see some conflict between the latitude given to local authorities in the use of these powers and their duty under section 91 of the Public Health Act 1936 to cause their districts to be inspected for the detection of statutory nuisances. Air pollution directly affects many more people than water pollution and we consider it anomalous that the provisions relating to public information on air pollution should be so much weaker than those relating to water. We further note that the anomaly appears to have been reinforced by the Government's decision, through the Local Government, Planning and Land Act 1980, to delete the provision in section 79(5) of the Control of Pollution Act 1974 which enabled the Secretary of State to be the final arbiter on what constitutes a 'trade secret' in the air pollution field. The effect of this amendment (like section 28(7) of the Health and Safety at Work etc. Act) is to leave firms with an absolute veto over what is published. By contrast, Part II of the Control of Pollution Act (section 42) places the onus on water polluters to satisfy the Secretary of State that information about their discharges should be withheld from public. In the long run we believe that these and other anomalies should be removed, with the provisions relating to air pollution reframed so as to make the powers mandatory instead of discretionary. This would form part of a general move towards putting all provisions relating to the disclosure of pollution control data on to a consistent footing. We return to this proposition at the end of the chapter.

2.63 We have given less detailed attention to the arrangements that apply in other fields of pollution control. We note, however, that legislative requirements and administrative procedures relating to the availability of information vary considerably, which we suspect may be more a reflection of historical accident than of genuine differences in operational needs. For instance, pesticides are an important area where practice is out of line with the more extensive requirements of Part II of the Control of Pollution Act. The recommendations of the Seventh Report (see paragraph 2.35) would help to remove that anomaly. Differences between the provisions of the Radioactive Substances Act 1960 (relating to disposal of radioactive waste) and those of Parts I and II of the 1974 Act are another area which we believe may need examining, although we note that data on radioactive discharges by British Nuclear Fuels Ltd and the electricity generating boards, which account for a very high proportion of all radioactivity discharged to the environment, are published regularly.

2.64 The question of confidentiality also arises in connection with the arrangements for exchange of information between regulatory authorities about new chemical substances. These arrangements have been the subject of much international discussion, notably through OECD(54) and the International Association of Environmental Co-ordinators(55). Regulations have been introduced in this country (SI 1982, No. 1496) to implement the requirements of Directive 79/831/EEC(56) on the notification of new substances (commonly known as the 'Sixth Amendment', because it amends for the sixth time Directive 67/548/EEC(57) on the classification, packaging and labelling of dangerous substances). The regulations provide for detailed disclosure of toxicity and other data to the Department of the Environment (DOE) and to the Health and Safety Executive, and for a summary of the data to be passed on to the Commission of the European Communities for transmission to the competent authorities in other Member States. With the exception of certain specified items for which confidentiality may not be claimed, information obtained under the regulations is treated as 'commercial in confidence' and it is not intended that any of this information will be disclosed routinely to the public. However, the Health and Safety at Work etc. Act 1974 requires companies to take all reasonable steps to determine the hazards associated with the products which they manufacture and use and to make information on hazards available to those likely to be affected by them. There is no equivalent requirement covering environmental hazards but, in its consultations with industry, DOE has taken the line that industry should make equivalent provision, and where appropriate the Department reserves the right to make information on potential environmental hazards available to the pollution control authorities. Data obtained under the regulations will provide a basis for the labelling of products and in this way at least some information on hazards will reach the public. In addition it will be public knowledge that the same requirement for information will apply to all new substances in future.

2.65 Another area of recent international activity, which we believe raises similar issues of public interest, is the control of transfrontier trade in hazardous wastes, highlighted by the saga of the dioxin waste from Seveso(58).

The Commission of the European Communities has proposed a draft regulation(59) which would, *inter alia*, require advance notification of any proposed transfrontier shipment of hazardous wastes within the European Community and allow competent authorities in Member States to raise objection to the shipment. The waste disposer would also have to certify that he had received the waste for disposal. (The proposal, which the House of Lords Select Committee on the European Communities has recently reviewed(60), has not yet been approved by the Council of Ministers.)

2.66 The Confederation of British Industry is concerned that, with membership of the European Community increasingly giving rise to new obligations on industry to disclose information, the institutions of the Community and some Member States do not have the legal or administrative machinery to ensure that information exchanged between industry and statutory monitoring and enforcement agencies is kept as secure as in the United Kingdom. There is therefore a risk of information being publicly released in excess of the agreed requirements of Community directives, particularly Directive 79/831/EEC. Both the disclosure of such information itself and the delay introduced by registration or certification procedures could affect commercial viability, particularly where sensitive marketing information is involved or in marginal cases such as the processing and re-use of material that might otherwise be considered waste. (As with weeds, there is a problem of definition: one man's waste may be another's raw material.) Moreover, in the case of trade in waste, information about the precise nature of the waste may itself be commercially sensitive. For this reason the CBI is opposed to the European Commission's proposed controls over transfrontier hazardous waste shipments being applied to re-cyclable materials. The Government shares the CBI's views.

2.67 We note industry's concern on these matters. Industry has a right to expect consistent and conscientious treatment on the part of regulatory authorities throughout the Community. Although it is probably too early to pass judgment on the notification scheme until more experience has been gained of its operation, there appears to be a strong presumption in favour of secrecy in the way it has been put into practice in the United Kingdom, which contrasts with more open arrangements in the Netherlands(61). We consider that the principles which are to apply to water discharges under Part II of the Control of Pollution Act should apply equally to the introduction to the environment of all potentially polluting manufactured products or wastes, and that all information legitimately required by pollution control authorities should in general be available publicly except in the very few cases where commercial secrets are genuinely at stake.

Confidentiality and national security

2.68 Section 42 of the Control of Pollution Act enables the Secretary of State to exempt from publicity information about water discharges which he is satisfied would be 'contrary to the public interest'. Perhaps surprisingly, there is no explicit equivalent provision applying to information about air pollution under section 79 or other forms of pollution (such as solid waste disposal), although Crown exemption would in practice give Ministers discretion over publication of any information which might have implications for national security. We accept that such considerations may be relevant in a limited number of cases. We think it important however that, in applying section 42 and developing the wider principles of public information which we have advocated, Ministers and other pollution control authorities should strictly confine their interpretation of 'public interest' to 'national security', and in particular should not withhold information merely because it might cause embarrassment.

Voluntary co-operation versus statutory compliance

2.69 Our review of the arguments for and against the public availability of pollution control data has led us to the conclusion that the recent trend towards greater openness needs to be accelerated and put on a more systematic footing. A crucial question is how far this process should be left to evolve on the basis of voluntary co-operation rather than be made the subject of tighter statutory controls. In the Second Report(39), the Commission stressed that there was already a close and constructive co-operation between industry and both central and local government, and that this co-operation had led to impressive improvements in the environment of Britain over the previous two decades. We endorse that comment, and have ourselves noted how this approach has in many areas been helping to break down the barriers of secrecy. Nevertheless it remains an issue—and in some ways an increasingly contentious one—whether the public is better served by an informal, confidential relationship between regulatory authorities and industry or by a formal, arms-length relationship.

2.70 It is sometimes suggested that local authorities in particular prefer the informal approach on the grounds that in this way they obtain more information from industry than they would under a formal statutory system of disclosure. It is also often the case that where nuisance is alleged, negotiation may produce quicker results than confrontation and prosecution. The outcome of prosecution is never a foregone conclusion, and if the case is dismissed the firm effectively has a licence to pollute. Some water authorities, too, have said to us that they obtain better results by negotiation on a semi-confidential basis. In this way, they would argue, they are helping industry to improve the quality of its effluents, and in support of the negotiations firms may volunteer internal research or monitoring data which go beyond the strict requirements of the law. The way in which IAPI negotiates the application of 'best practicable means' reflects a similar relationship with the individual firm.

2.71 We would not wish to see this kind of informal dialogue between regulatory authorities and industry being unduly inhibited. 'Thinking the unthinkable' is an essential aid to progress and is impossible under institutionalised freedom of information, which effectively prevents public authorities from receiving information in confidence. Moreover, an interactive approach need not be inconsistent with firmness and bringing defaulters to book where necessary. Because our regulatory agencies do not always act in an adversarial way, it does not necessarily mean that there is a corrupting 'cosiness'. On the other hand, evidence can be found (from the United States of America and elsewhere) of the reverse being true; and that reinforces our belief that there should be appropriate safeguards which place limits on what can be shielded from public view and discourage the kind of attitude which is referred to in this comment in evidence to us from the Institution of Water Engineers and Scientists:

> 'There are some industrial concerns which refuse to allow publication by pollution control authorities of information about effluents discharged to tidal waters by those firms. Mainly such refusals seem to arise not because of a strong desire to conceal information but simply because a statutory right does exist and some managements believe in exercising that right.'

2.72 The success of our regulatory authorities needs to be judged on their performance rather than their methods. That is why local authorities and the public need information—about the controls imposed in particular cases and how far they comply with general standards set for the type of process or pollution in question; about the arrangements for monitoring compliance and about the results obtained from it. Only in exceptional circumstances does this requirement need to be modified to protect genuine trade secrets.

Conclusions

2.73 Our review of the issue of confidentiality has borne out the foresight of our predecessors in highlighting it as a topic for widespread debate. Although some progress has been made, we are not satisfied that the tasks set by the Second Report (see paragraph 2.33) have been tackled systematically enough or with sufficient urgency. We have been struck by the asymmetry between the various statutory provisions and administrative procedures relating to public disclosure of, or public access to, information obtained by pollution control authorities. Powers may be discretionary or mandatory, and presumptions in favour of disclosure vary considerably according to how legislative provisions are framed. We have sought to illustrate the more important anomalies in the box. We see no justification for such an inconsistent approach to the fundamental principle advocated in successive reports and we believe the long-term aim should be to bring all confidentiality criteria and disclosure procedures on to a common basis.

2.74 For a variety of reasons industry is nervous about the implications of wider disclosure of information—the desire to protect competitive advantage; the feeling that public opinion is perhaps biased against industry; the fear of vexatious complaints. Hence the need for secrecy, which in reality appears essentially to be confined to information about industrial processes, tends to be given quite disproportionate emphasis. We understand this concern, but we think it is misconceived.

2.75 Both the Second and the Seventh Reports pointed out that unnecessary secrecy hindered independent evaluation of data which could be of benefit to the environment in bringing to light risks which had previously been

Some limitations to the public's right of access to information to which pollution control authorities are statutorily entitled

INFORMATION	PUBLIC RIGHT OF ACCESS
Air pollution	
INDUSTRIAL AIR POLLUTION INSPECTORATE: *Alkali etc Works Regulation Act 1906*	
Registration details of scheduled processes—nature of process, name and address, etc*	YES: the Inspectorate keeps a public register.
Technical data—emission tests, BPM limits and other abatement details	NONE, though local authorities are told BPM limits and District annual reports are published (see para 2.58).
LOCAL AUTHORITIES: *Clean Air Acts 1956 and 1968*	
Plans for non-domestic furnaces and chimneys;* grit and dust emissions; fuels used in furnaces	NONE: disclosure of trade secrets prohibited without operator's consent or statutory requirement (2.59).
Control of Pollution Act 1974, Part IV	
Emissions to the air from any premises, including registered works but not private dwellings. Registered works need disclose only information of the kind that IAPI could require under the Alkali Act	YES, if authority so decides after consulting business and amenity groups. Public register is kept. Appeal to Secretary of State on grounds that data collection too costly or disclosure prejudicial to trade secrets or contrary to public interest (2.49; 2.61).
Water pollution	
WATER AUTHORITIES: *Rivers (Prevention of Pollution) Act 1961*	
Any data about applications, discharge consents or effluent samples taken by the authority	NONE unless discharger gives permission or there is a statutory requirement for disclosure (2.57).
Control of Pollution Act 1974, Part II (in process of implementation)	
Applications for consents to discharge effluent to rivers, estuaries or coastal waters*	YES: applications must be publicised unless authority considers discharge insignificant or Secretary of State agrees publicity would prejudice trade secrets or be contrary to public interest.
Applications, consents granted, conditions imposed, water and effluent analyses and any remedial measures taken	YES: the authority must keep a public register, subject to safeguards as above (2.49; 2.57).
Waste disposal	
LOCAL AUTHORITIES: *Control of Pollution Act 1974, Part I*	
Disposal arrangements for special wastes*	NONE
Applications for disposal licences—type and quantity of waste, methods, safeguards etc*	YES: the authority must keep a public register of disposal licences.
New chemicals	
HEALTH AND SAFETY EXECUTIVE and DEPARTMENT OF THE ENVIRONMENT: *Health and Safety at Work etc Act 1974*	
Physical and chemical properties, toxicity and ecotoxicity, production and proposed uses*	NONE, though data on potential environmental hazards may be disclosed to local authorities (2.64).
Pollution of the sea	
DEPARTMENT OF ENERGY: *Prevention of Oil Pollution Act 1971*	
Spills and discharges of oily effluent from off-shore gas and oil installations*	NONE, though figures for total spillages and discharges are published annually.
HM COASTGUARD: *Merchant Shipping Act 1979*	
Details of actual and probable discharges of oil and oily mixtures from certain ships*	NONE, though HM Coastguard alerts local authorities as necessary. An annual survey of incidents is published.
Radioactive substances	
DEPARTMENT OF THE ENVIRONMENT: *Radioactive Substances Act 1960*	
Applications for discharge authorisations—amount of specified elements in discharges and in environmental materials*	NONE, though local authorities are told of authorisations except when national security is involved. Disclosure of process data or trade secrets without the operator's consent is prohibited. An annual survey of discharges is published.

General

- Inspectors (e.g. from IAPI and local authorities) have wide powers under the Health and Safety at Work etc Act 1974 to require information about processes and premises; NONE of this may be disclosed to the public without the operator's permission (2.59).
- Section 93 of the Control of Pollution Act 1974 gives pollution control authorities a general power to require any information reasonably needed for their duties under the Act. Section 94 prohibits the disclosure of any information relating to a trade secret (but not any other information) obtained by virtue of the Act unless the owner consents or there is a statutory requirement for disclosure.

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* Indicates information which must be reported to control authorities or included in licence/consent applications; the authorities may require the provision of other information at their discretion.

undervalued or even overlooked. Knowledge that its activities may come under public scrutiny acts as a vital discipline for the pollution control authority; it will also profit technically and scientifically from an open, informed peer-review of its work and will command much greater public confidence.

2.76 We recognise that a free exchange of information at plant level between management and regulatory authorities about the details of industrial processes can be valuable in determining 'best practicable means' and 'best practicable environmental option' (see Chapter III). We accept that some of these details may be commercially sensitive and should not therefore be released without the firm's consent. On the other hand, we see no case for withholding from the public information which regulatory authorities are entitled by statute to receive or obtain. Where restriction of public access is necessary in order to protect trade secrets, we consider that this should be the subject of a proper procedure, as in Part II of the Control of Pollution Act (see paragraph 4.31), and not merely left to the authority's discretion or the firm's veto. In such cases the appropriate Minister should review the position regularly and withdraw or vary his certificate at the earliest opportunity.

2.77 As we have already indicated, we believe that Part II of the Control of Pollution Act provides a useful model for the open approach to pollution control we have advocated; yet the key provisions are only now being brought into operation. The provisions of the Act concerned with air pollution, and the related provisions in the Alkali, Clean Air and Health & Safety at Work etc. Acts, present a far less satisfactory picture, with a much greater presumption in favour of secrecy. The same is true of the arrangements relating to new pesticides, new chemicals and radioactive waste. We consider that the aim of policy should be the progressive removal of existing discrepancies, so that in the long run the public will be entitled to the fullest possible amount of information on all forms of environmental pollution, with the onus placed on the polluter to substantiate a claim for exceptional treatment. Accordingly we **recommend** that a guiding principle behind all legislative and administrative controls relating to environmental pollution should be a presumption in favour of unrestricted access for the public to information which the pollution control authorities obtain or receive by virtue of their statutory powers, with provision for secrecy only in those circumstances where a genuine case for it can be substantiated.

2.78 From this general, overriding recommendation the following specific **recommendations** flow:

(i) The information to be recorded in the public registers under Part II of the Control of Pollution Act 1974 should be prescribed in accordance with our general principles and in a way which minimises the cost of providing public access (paragraphs 2.49 and 2.57).

(ii) Section 28(7) of the Health and Safety at Work etc. Act 1974 should be amended to remove the obsolete and unnecessary bar on disclosure of information by the Industrial Air Pollution Inspectorate and other pollution control authorities (paragraph 2.59).

(iii) Consideration should be given to establishing public registers of information relating to the control of atmospheric pollution from both registered and non-registered works, containing details of agreed 'best practicable means' and the results of emission tests and environmental monitoring by both the Industrial Air Pollution Inspectorate and local authorities (paragraph 2.60).

(iv) The powers of local authorities under sections 79 and 80 of the Control of Pollution Act 1974 to obtain and publish information about atmospheric pollution should be made mandatory and brought into line with Part II of the Act; this should include restoration of the Secretary of State's role as final arbiter on what constitutes a trade secret (paragraph 2.62).

(v) As an interim measure, positive encouragement should from now on be given to local authorities to make use of their powers under sections 79 and 80 of the Control of Pollution Act 1974 and to establish local consultative committees. Local authorities should also be encouraged to make available regular information on their pollution control activities generally, for example in the form of annual reports by environmental health departments (paragraph 2.61).

(vi) In accordance with our general recommendation, the introduction to the environment of all potentially polluting substances, manufactured products and wastes should in general be subject to a uniform system of controls, with provision for public information modelled on Part II of the Control of Pollution Act 1974. Administrative and statutory requirements for public information, including those relating to pesticides (paragraph 2.63), radioactive waste (paragraph 2.63), new chemicals (paragraph 2.64) and transfrontier hazardous waste shipments (paragraph 2.65) should therefore be brought progressively on to a common footing (paragraph 2.67).

(vii) Where a Minister or other pollution control authority has the power to withhold information in the public interest, the power should be exercised only when this is essential on grounds of national security (paragraph 2.68).

(viii) In cases where protection of trade secrets is agreed to be justified, the position should be reviewed regularly and Ministerial certificates withdrawn or varied at the earliest opportunity (paragraph 2.76).

CHAPTER III

DOMESTIC TRADITIONS AND INTERNATIONAL INFLUENCES

When men understand what each other mean, they see, for the most part, that controversy is either superfluous or hopeless.
John Henry, Cardinal Newman, 1839

Introduction

3.1 In this chapter we discuss some of the international factors which have had an increasingly significant effect on pollution control policy in the United Kingdom. Of these, the most influential during the past decade has been the United Kingdom's membership of the European Community. We feel it is useful to examine our country's environmental policies and institutional arrangements, as they have evolved, and to see whether their distinctive characteristics might be in need of further modification in the light of the growing international dimension.

3.2 In the Royal Commission's Fourth Report(2) a brief account was given of the structure for pollution control in the United Kingdom. This was followed by a more detailed account (last revised to mid-1978) by the Department of the Environment in No. 9 of the Pollution Paper series, 'Pollution Control in Great Britain: How it Works'(62). Although still substantially correct, the Paper needs updating in a number of respects and is now out of print. It is a valuable reference document and we **recommend** that the Department of the Environment should produce a revised edition of Pollution Paper 9 as soon as possible and keep it regularly updated.

General characteristics of pollution control in the United Kingdom

3.3 As the Fourth Report noted, executive responsibility for pollution control rests in general with local and water authorities. Central government departments (among which the Department of the Environment (DOE) has a co-ordinating role) are principally concerned with exercising overall budgetary control, promoting the necessary legislation, and advising authorities on its implementation. In certain specific areas, however, direct control is exercised by central government organisations and agencies. At present these include (in England—the arrangements in Scotland, Wales and Northern Ireland being different in a number of respects) the Industrial Air Pollution Inspectorate (formerly the Alkali and Clean Air Inspectorate) of the Health and Safety Executive (HSE), which deals with air pollution from certain industrial processes (mainly those which give rise to particularly noxious or offensive emissions or which are technically difficult to control); the Ministry of Agriculture, Fisheries and Food (MAFF) (pesticides, other agricultural chemicals and dumping at sea); the Department of Transport (vehicle standards, aircraft noise and marine pollution caused by shipping); DOE (hazardous waste); HSE and DOE jointly (new chemicals); and DOE jointly with several departments (radioactivity).

3.4 Characteristically, British legislation, in the environmental field and elsewhere, places a duty on a control authority (which need not necessarily be an arm of central government) to achieve certain objectives, for which it is provided with appropriate powers backed by legal sanctions. The authority is given considerable discretion as to how it achieves its objectives, including in many cases the pace at which it moves. There is also a tradition, both in legislation and in administrative practice, of pragmatism, of gradual, negotiated (rather than mandated) raising of standards, and of caution in not going beyond what is seen by the parties concerned as reasonably practicable. The 'technology-forcing' element, as practised in some countries such as Japan and the United States, is largely absent.

3.5 The advantages of the British philosophy have been stated many times(23), not least by the Royal Commission in its Fifth Report(3). Its success does however depend not only on a high degree of mutual trust existing between the polluter and the control authority but also on the public being satisfied that environmental improvement is not being too readily delayed by commercial pressures. As Lord Sherfield has said(63), British practice 'depends on effective control to ensure that the objectives are met by the best practicable means and that these do not degenerate into the cheapest tolerable means'. We have seen in Chapter II that the growth in environmental awareness and concern has created a need for more explicit demonstration that proper standards are being set and complied with. The as yet inoperative provisions in the Control of Pollution Act 1974 for public registers of consents granted to dischargers by water authorities, and the complementary recommendations relating to emissions to the atmosphere in the Fifth Report, are designed to help to meet such a need.

3.6 Membership of the European Community and ratification of various international conventions have reinforced this trend towards greater explicitness and have brought the British approach under increasingly critical scrutiny. The resulting conflict has been seen by some commentators(23, 64) as due, at least in part, to the different history and traditions of the common law and the civil (Roman) law—the former with its interplay of precedent and adjustment to change, the latter with its preference for precise rules. On the other hand, the use of legislation to force the pace, often with precise timetables and standards centrally specified, is not peculiar to countries in the civil law tradition, as may be seen from practice in the United States. The differences may therefore stem more from social, political and economic than from purely legal factors. Rather than seeing the United Kingdom's international dealings on environmental issues in terms of a contest in which each side seeks, from entrenched positions, to score points for or against 'the UK philosophy', we find it more helpful to see it as a dynamic process which has helped all parties to clarify what they are seeking to achieve, both as a Community and as individual Member States(25).

The European Community's involvement in environmental policy

3.7 It is only in the past decade that the members of the European Community have come to regard the essentially economic aims of the 1957 Treaty of Rome as extending to the protection of the environment. The first decision in principle was taken at a summit meeting of the original Six in October 1972, at which heads of state invited the European Commission to develop an environmental policy for the European Community. The resultant programme of action was approved by the Council of Ministers of the enlarged European Community in November 1973(65).

3.8 The original declaration from the 1972 summit meeting stated that:

> 'Economic expansion is not an end in itself: its first aim should be to enable disparities in living conditions to be reduced... It should result in an improvement in the quality of life as well as in standards of living. As befits the genius of Europe, particular attention will be given to intangible values and to protecting the environment...'(65)

This broad principle was restated in many forms in the subsequent First Action Programme and the accompanying declaration from the 1973 meeting, but perhaps the most convenient formulation is to be found in the introduction to the second, updated programme, which the Council of Ministers approved in May 1977:

> 'The promotion throughout the Community of a harmonious development of economic activities and a continuous and balanced expansion, which constitute the paramount purpose of the Community (Article 2 of the EEC Treaty), *cannot now be imagined* in the absence of an effective campaign to combat pollution and nuisances or of an improvement in the quality of life and the protection of the environment.'(66) (our italics)

3.9 The justification for a European Community environmental policy accordingly rests not on any particular clause of the Treaty of Rome (which contains no reference to the environment) but on an agreed re-interpretation of the Treaty's fundamental objectives. Consequent upon that, the legitimacy of the various Directives, Regulations and Decisions relating to environmental pollution rests either on Article 100 of the Treaty (which provides for the approximation of laws between Member States) or on Article 235 (which empowers the European Community to take measures to deal with any unforeseen circumstances which would otherwise impede its objectives), and in some cases it rests on a combination of the two(23, 67, 68). Although the view is still occasionally expressed that the various measures taken under the

European Community's environmental action programmes are of doubtful legal foundation(69), we consider that this bears little relation to political realities or to the growing number of decisions by the European Court(67). We are encouraged to note that the House of Lords Select Committee on the European Communities, despite its earlier reservations(70), now regards the legality of the programmes as settled beyond reasonable doubt(68).

3.10 It is outside the scope of this Report to give a comprehensive account of the European Community's environment action programmes and of the various directives which have flowed from them, although we comment on some of the directives in connection with the areas of policy which we deal with in Chapters IV and V. For this purpose we have not sought to go over in detail the ground already covered by the House of Lords Select Committee on the European Communities, whose Sub-Committee G keeps European Community environment policy under continuous scrutiny and recently presented its detailed views on the first two action programmes(71, 72). We have also been aware that the impact of European Community environment policy on the United Kingdom has been the subject of a major independent study by the Institute for European Environmental Policy(25). We therefore propose merely to highlight certain features of the latest Action Programme and the role of the United Kingdom in its evolution.

3.11 The European Commission's proposals for a Third Action Programme were approved in principle by the Council of Ministers in February 1983(19), which on this occasion decided to indicate, in its covering resolution, eleven priority areas for action by the Community (see box overleaf). The Programme itself, as annexed to the resolution, seems to us to be a far more coherent statement of policies and aims than the previous two programmes, and reflects a period in 1980 and 1981 during which the programmes and their achievements were subjected to critical appraisal by the Council and the European Commission(72). It also represents a logical development from the earlier programmes, the main objectives of which have been substantially achieved. Much of the emphasis in the First and Second Action Programmes was on the reduction of existing pollution and nuisances—on correcting the errors of the past by identifying particular problems and devising measures for tackling them in order of priority, although the need for preventive action was not overlooked. The importance of harmonisation of national policies, in the interests of the proper functioning of the common market, was also stressed.

3.12 Although in substance containing little that is specifically new, the Third Action Programme nevertheless reflects a distinct shift of emphasis. The Programme has become much broader in its approach, and (whilst aiming to complete the specific measures initiated in the earlier programmes) is now much more concerned with establishing a general framework for the positive management of resources so as to meet the environmental needs of the future. In its introductory section the Programme states that 'the resources of the environment are the basis of—but also constitute the limits to—further

PRIORITY AREAS FOR EUROPEAN COMMUNITY ACTION ON THE ENVIRONMENT

Extract from Resolution of the Council of the European Communities of 7 February 1983 on the continuation and implementation of a European Community policy and action programme on the environment (1982 to 1986)

THE COUNCIL OF THE EUROPEAN COMMUNITIES

. . .

Takes note of the action programme annexed hereto and approves the general approach thereof;

Declares that it is important for Community actions to be carried out particularly in the following areas:

(a) integration of the environmental dimension into other policies;

(b) environmental impact assessment procedure;

(c) reduction of pollution and nuisance if possible at source, in the context of an approach to prevent the transfer of pollution from one part of the environment to another, in the following areas:

- combating atmospheric pollution, especially by NO_x, heavy metals and SO_2, *inter alia* by implementing Council Directive 80/779/EEC of 15 July 1980 on air quality limit values and guide values for sulphur dioxide and suspended particulates;
- combating fresh-water and marine pollution *inter alia* by:
    - (i) implementing Council Directive 76/464/EEC of 4 May 1976 on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community and Council Directive 78/176/EEC of 20 February 1978 on waste from the titanium dioxide industry, and
    - (ii) the action programme of the European Communities of 26 June 1978 on the control and reduction of pollution caused by hydrocarbons discharged at sea;
- combating pollution of the soil;

(d) environmental protection in the Mediterranean region, paying particular attention to the specific aspects of that region when giving practical application to the action programme;

(e) noise pollution and particularly noise pollution caused by means of transport;

(f) combating transfrontier pollution;

(g) dangerous chemical substances and preparations; e.g. the supplementing and application of Council Directive 79/831/EEC of 18 September 1979 amending for the sixth time Directive 67/548/EEC on the approximation of the laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances;

(h) waste management, including treatment, recycling and re-use, and in particular toxic and dangerous waste, including transfrontier transport of such waste, and the review of the list of toxic or dangerous substances and materials in the Annex to Council Directive 78/319/EEC of 20 March 1978 on toxic and dangerous waste;

(i) encouraging the development of clean technology, e.g. by improving the exchange of information between Member States;

(j) protection of areas of importance to the Community which are particularly sensitive environmentally;

(k) cooperation with developing countries on environmental matters.

economic and social development', and goes on to say that 'environmental policy is a structural policy which must be carried out without regard to the short-term fluctuations in cyclical conditions, in order to prevent natural resources from being seriously despoiled and to ensure that future development potential is not sacrificed'(19). A number of important principles are seen as contributing to these broad aims:

(a) greater emphasis should be placed on preventive action than on purely remedial measures;

(b) more attention should be paid to co-ordination of pollution control measures in different environmental media to avoid the problem of pollution merely being transferred from one medium to another; and

(c) there should be closer integration of environmental and socio-economic policies (to which the use of environmental (impact)* assessment is seen as making a major contribution).

Since these principles have much in common with ones which both the Royal Commission and the House of Lords Select Committee have advocated in successive reports, we pay particular attention in this Report to the question how far the institutional arrangements and practices of the United Kingdom can contribute towards these European Community objectives.

Rationale of United Kingdom pollution control policies

3.13 The principle of 'best practicable means' (BPM) as an instrument of progressive pollution control has a long history in this country and has been much discussed, by the Royal Commission and by others(3, 23, 50). It is generally held to be a peculiarly British inspiration. BPM originated in attempts to curb air pollution in the early nineteenth century, and has enjoyed statutory force in the Alkali Acts since 1863; it is also referred to in section 94(5) of the Public Health Act 1936, which provides that where a firm is prosecuted for causing certain types of statutory nuisance it shall be a defence for the firm to prove that the 'best practicable means' have been employed to prevent or counteract the effect of the nuisance. It was not until 1956, however, that BPM was actually defined by statute. Section 34(1) of the Clean Air Act 1956 gives the definition as follows:

> ' "practicable" means reasonably practicable having regard, amongst other things, to local conditions and circumstances, to the financial implications and to the current state of technical knowledge, and "practicable means" includes the provision and maintenance of plant and the proper use thereof.'

Since then, the statutory use of the term has been extended to the noise abatement field by sections 58(5) and 72 of the Control of Pollution Act 1974, which give a broadly similar definition. BPM is to be distinguished from 'best available technology' (BAT), a term current in the Unitied States, which implies the maximum abatement regardless of cost or whether it is necessary on environmental grounds. A concept similar to BAT may orginally have been intended in the European Commission's term 'best technical means available' (BTMA), as used in Directive 76/464/EEC(13), although as we note in paragraph 3.25 some obscurity surrounds this issue and in practice the term appears to have acquired a meaning not unlike that of BPM.

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*There is some inconsistency in European Community documents in the use of the terms 'environmental assessment' and 'environmental impact assessment', which for practical purposes can be assumed to have equivalent meaning.

3.14 According to the Department of the Environment, 'it is not an aim of United Kingdom pollution control policy to eliminate discharges to the environment which are not likely to cause damage' (see paragraphs 1.9-1.12): 'moreover in some cases adverse environmental effects may need to be tolerated to a certain extent, for example where the cost of eliminating the damage is unacceptably high'. Potentially polluting discharges and emissions are generally by-products of processes which bring net benefits; and although less polluting products and processes will in principle be desirable, their introduction depends both on technical feasibility and on the extent to which the environmental benefit outweighs the additional cost. Other features claimed to be characteristic of the British approach are its flexibility and pragmatism. These stem partly from the democratic traditions of consensus and local discretion to which we have already referred; they also reflect a tendency to focus less on eliminating pollutants at source than on restricting to an acceptable level their effects after they have entered (and been absorbed by) the environment, or in other words to consider the net effect on the quality of the receiving environment. It is often said that accidents of geography have encouraged this approach, and that length of coastline, short rivers, strong tides, and prevailing winds make it possible for much of the pollution generated in the British Isles to be swept rapidly away from the population who would otherwise be affected by it. However the view that pollution problems are thereby avoided is being increasingly challenged (see paragraphs 3.23, 3.26 and 6.3).

3.15 The idea that one should look at net effects on environmental quality, which would vary according to location, and not merely at the quantity and nature of the substances that leave the factory chimney or outfall, is strongly supported by British industry(69, 73, 74). The Chemical Industries Association, for example, has stressed the distinction between 'pollution' and 'contamination' (see paragraph 1.11), which it believes is not sufficiently understood in continental Europe, and has produced examples of the economic penalties that would result from a policy which sought to eliminate discharges, rather than controlling the quality of the receiving environment(73). Figure 3.1 shows the capital costs, calculated for a United Kingdom company from United States data, of reducing the biochemical oxygen demand* of effluent containing both inorganic and organic chemicals. This illustrates the law of diminishing returns, with costs escalating steeply as the level of contamination approaches zero. Similar issues are raised by European Community Directive 82/176/EEC (on mercury discharges by the chlor-alkali industry)(37), which many industry witnesses see as an initiative taken by the

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*Most organic pollutants can be broken down by bacteria and other micro-organisms. This process depletes oxygen dissolved in the water sometimes to the extent that normal aquatic life cannot be supported. The biochemical oxygen demand is a measure of the capacity of a contaminant or mixture of contaminants to deplete water of oxygen in this way.

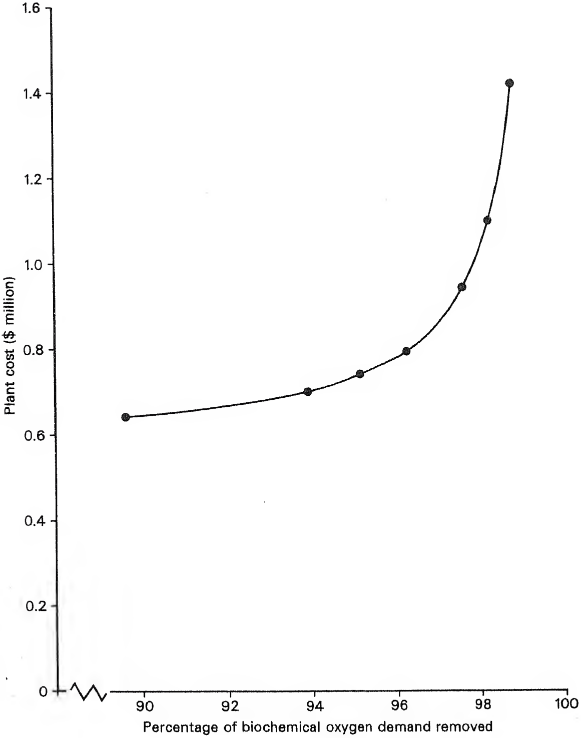

Figure 3.1
Example of capital costs of effluent treatment

Calculated for a UK company from US data. Effluent contains both inorganic and organic chemicals.

Source: Reference (73).

Community in response to emotional rather than scientific arguments and one which has imposed significant costs with little discernible benefit to the environment (see, however, paragraph 3.26).

3.16 In fact the United Kingdom is not alone in its enthusiasm for the environmental quality approach. A similar approach may, for example, be observed in the operation of the major French river authorities *(Agences Financières de Bassin)*(75); while the same need was recognised in the European Community's First Action Programme, which contained the statement that in setting quality objectives (see box opposite) for the environment 'proper account must be taken of the specific characteristics of the regions in question'(65).

Ideological dispute in the European Community

3.17 The way in which the Commission of the European Communities proceeded to develop the 1973 Action Programme in relation to 'black list' (List I) substances discharged to water (see paragraphs 1.12 and 3.26) proved at the time to be highly contentious from the British viewpoint. Matters came to a head in 1975 over the dangerous substances in water Directive (76/464/EEC)(13), where the British preference for environmental quality objectives (EQO—see box) appeared to be set on a collision course with a general continental preference for uniform emission standards or limit values. The outcome of this dispute was a not altogether satisfactory compromise which offered Member States a choice between EQOs and limit values, with only the United Kingdom opting for the former(25, 71). It was, however, agreed that the use of EQOs was the correct approach when dealing with 'grey list' (List II) substances.

3.18 With hindsight, it now appears to have been a somewhat unnecessary battle fought from artificially entrenched positions. Unfortunately the arguments have become part of the folklore which continues to colour some of the evidence we have received and the views of certain commentators. A number of factors can be seen to have contributed to the dispute. From the continental viewpoint, the EQO approach appeared intrinsically less suitable as a solution to discharges or emissions of 'black list' substances far from the sea, particularly when pollution was carried across frontiers (for instance, by the Rhine). The emission standard or limit value approach offered quicker and administratively simpler solutions, besides being possibly more in tune with the legislative traditions of most members of the European Community (paragraph 3.6). From a British viewpoint the European Commission's proposals seemed to require 'a repudiation of the lessons we have learned from 160 years of our own history'(23). The much proclaimed virtues of flexibility were, however, in danger of being translated into a form of dogma, which overlooked the fact that the allegedly rival approaches had for long co-existed in British practice.

TERMS USED IN POLLUTION CONTROL

Much discussion about different approaches to pollution control has been based on an assumed contrast between environmental quality standards and emission standards. The use of these terms and other phrases, however, is far from consistent and in practice the approaches are not so distinct as is often supposed.

An **environmental quality objective** (EQO) is a statement of the quality to be aimed for in a particular aspect of the environment. The objective may not yet be attainable and will often be phrased in qualitative terms, for example 'to ensure that the quality of water in a stretch of river is such that coarse fish will maintain healthy populations.' An **environmental quality standard** (EQS) is generally more specific and expressed in quantitative terms; it is usually part of a regulatory framework and has some legal basis. It specifies the maximum permissible level of a contaminant or the minimum permissible level of some positive environmental attribute. Several examples are found in European Community directives such as that on bathing waters (paragraph 4.57). An EQS for the air is sometimes termed an **air quality standard** (AQS).

In contrast, an **emission standard** is a limit on the emission or discharge of a contaminant from a particular source. An early example may be found in the Alkali etc Works Regulation Act 1906, which set emission standards for four classes of alkali, sulphuric acid and hydrochloric acid works. Conceptually the simplest system is that of a **uniform emission standard** (UES), where the same limit is placed on all emissions of a particular contaminant.

A number of European Community directives specify **limit values** (LV) in connection with both EQSs and emission standards; these define outer limits within which individual Member States must set EQSs and emission standards. The smoke and sulphur dioxide Directive, for example (paragraph 5.3), sets limit values for the ground level concentrations to be met during specified periods. However, Member States have a duty, under this Directive, to work towards more stringent EQOs. The dangerous substances in water Directive (paragraph 1.12) gives Member States the option of controlling pollution caused by 'black list' substances either by using LVs for discharges or on the basis of EQSs.

3.19 For instance, United Kingdom standards for discharges into rivers from sewage works have historically shown a high degree of uniformity, being based on a standard laid down by the Royal Commission on Sewage Disposal of 1896–1915. Similarly, in the air pollution field, the Industrial Air Pollution Inspectorate's application of BPM-based controls has produced a series of emission standards (or, more correctly, limit values), which take into account differences between polluters in respect of abatement costs but largely ignore differences in respect of environmental capacity. The present Chief Inspector has pointed out(50) that even with the recent introduction of air quality standards (for instance, under the smoke and SO_2 Directive, 80/779/EEC) 'BPM remain the corner stone of industrial air pollution control .... Air Quality Standards are *not* licences to pollute up to a given level; rather the concentration of any pollutant should be kept as low as is reasonably practicable and in any case should not exceed the AQS'. The Inspectorate's approach can thus be seen to be based on a narrower interpretation of BPM than that contained in the Clean Air Act 1956 (see paragraph 3.13).

3.20 In the case of radioactivity, because no radioactive discharge can be regarded as free from risk (see Chapter II), United Kingdom practice, in accordance with the recommendations of the International Commission on Radiological Protection, is to set controls to achieve human exposures which are as low as reasonably achievable (ALARA), having regard to economic and social factors and subject to the overriding standards set by ICRP. In other fields, such as noise abatement and waste disposal, the approach is very much a hybrid one of informal EQO and BPM. It is really only in recent years, in the field of discharges to rivers and estuaries, that the concept of EQO/EQS has been worked up into a potential tool of pollution control. We see considerable force in the suggestion(25) that the United Kingdom only adopted a firm and workable EQO policy—as opposed to a vague concept—in response to the pressures brought upon it by European Community initiatives. The novelty of the approach is demonstrated by the fact that there is as yet no such regime in operation nationally in estuarine waters.

3.21 Thus whilst the Department of the Environment's statement to us of the characteristics of United Kingdom pollution control policy (paragraph 3.14) may be reasonable as a broad generalisation, at a more detailed level there is much variety in practice. Both the aims of pollution control and the choice of mechanisms are influenced by the specific features of various pollution problems, including the assessment of risk (see Chapter II). Membership of the European Community may have caused the United Kingdom to over-protest its adherence to the environmental quality philosophy, but the experience of the past decade has been salutary—both for this country in stimulating clearer thinking about the philosophy and its practical application and within the European Community at large in fostering a wider appreciation of the advantages of a more flexible approach.

3.22 The latter is evident from some remarks attributed in 1981 to M. Michel Carpentier, as outgoing head of the European Commission's

Directorate-General for the Environment, Consumer Protection and Nuclear Safety (DG XI):

> 'I regard (the EQO/UES controversy) as an artificial argument. It is more a battle of principles than of realities. The best approach would be to look at the environmental quality objective—the EQO—for a particular area and, as a minimum step, use the best techniques available to determine the correct emission standards—the UES. Then allocate the permissible amounts of effluent among the polluters in the area.'(76)

M. Carpentier's last point indicates an approach which has yet to be put into practice in the United Kingdom, although we understand that the Federal German authorities have adopted it in relation to certain discharges to the German section of the Rhine.

3.23 More recently, a senior official of DG XI described in more detail the comparative advantages and disadvantages of quality objectives and emission standards, as the European Commission perceived them. He argued both approaches had a part to play:

> 'Uniform emission standards are attractive to the administrator because they are more easy to implement and control. In the case of heavy pollution they offer a quick method for its reduction. They can be seen to contribute readily to the Community desire to avoid unequal conditions of competition and to support the 'polluter pays' principle.
>
> 'Emission standards are a means of controlling pollution at source and this is accepted to be a sound principle for both economic and technological reasons when applied to industrial effluents before they are treated in admixture with sewage. If there is a tendency to safeguard sewage treatment plant by such means then surely it is logical to extend the principle to protect the general aquatic environment which is the ultimate recipient of pollution. It is especially necessary to be careful when dealing with the substances which are both persistent and toxic.
>
> 'Environmental quality objectives make the best use of the receiving capacity of waters. They offer more flexibility and better efficiency because regulatory measures may be selectively applied to control particular sources of pollution. It is suspected that their associated administration and monitoring may be costly if efficiently undertaken but this must be offset against the obvious advantages when it is not seen to be necessary to remove as much of the pollution as may be technically feasible. The main objections to the use of quality objectives relate to the lack of knowledge about what actually happens to such pollutants once they enter the environment. First, it is said that it is impossible to determine the capacity of the environment to assimilate pollution. Second, there is a lack of knowledge of the synergistic effects of pollutants in combination with other, possibly harmless, substances. Third, account is not taken of the complex meteorological factors on transport and dispersion which include differences in river flows and the uncertainty of other seasonal climatic factors. In some respects, quality objectives may thus be seen to elude the problem rather than to solve it.'(77)

3.24 The Commission of the European Communities may be criticised for putting forward certain proposed standards of dubious scientific validity, for insisting on measures which are over-rigid in their application, and for the suggestion (which we would reject) that natural advantages of geography are a distortion of competition which should somehow be eliminated. However, attempts by the United Kingdom (and perhaps other Member States) to introduce greater flexibility into the system have in some cases produced results which border on the ridiculous. We discuss one of these cases—the bathing water Directive— in Chapter IV. Another example is provided by Directive 75/716/EEC on the sulphur content of gas oil(78). This provides that only two grades of gas oil (a term which broadly covers domestic heating oil and diesel fuel) may be sold in the European Community and that use of the grade with a higher sulphur content shall be confined to zones designated by Member States. The United Kingdom Government decided to designate the whole of the country, with the exception of the road network, as a 'zone' for this purpose—an outcome which may have come somewhat as a surprise to the European Community draftsmen(25) (although we gather the Danish Government took similar action).

3.25 Despite these possible criticisms, we have been encouraged by the developments in the European Commission's attitude to the choice of pollution control instruments which can be seen in the Third Action Programme and other recent documents. The recently agreed Directive 83/513/EEC on limit values and quality objectives for cadmium discharges(79) states that Member States may grant authorisations for new plants 'only if those plants apply the standards corresponding to the best technical means available when that is necessary for the elimination of pollution... or for the prevention of distortion of competition'. This contrasts with Directive 82/176/EEC (on mercury discharges by the chlor-alkali industry)(37), which requires authorisations to 'contain a reference to the standards corresponding to the best technical means available for preventing discharges of mercury' (see paragraph 3.15). The cadmium Directive appears to reflect an unpublished interpretation of the parent Directive 76/464/EEC by the Council of Ministers to the effect that 'best technical means available' is to take into account the economic availability of those means(25, 80); it also provides evidence of some convergence of the European Commission's philosophy and the long established practice of the British Industrial Air Pollution Inspectorate. It indicates a recognition by Britain that EQOs should not be used to permit avoidable discharges of potentially polluting substances, and acceptance by other Member States that there must be some flexibility in emission standards.

3.26 The United Kingdom may well have been justified in the past in resisting and seeking to modify some of the more impracticable proposals emanating from the European Commission, but we believe that it needs to demonstrate a more positive attitude towards environmental measures in its international negotiations. Whilst the United Kingdom may not have gone so far as to argue that its philosophy, evolved in the context of a unique combination of legal system and geographical features, is universally applicable, we nevertheless believe it has to some extent over-protested in favour of domestic practices. If only in the interests of international co-operation, the United Kingdom must respond to the views of its European Community partners, and it should do so in a way that ensures that constructive criticism is not mistaken for obstructiveness. Foresight and prudence also suggest that the United Kingdom should reappraise its stance on irretrievable discharges to the sea of toxic substances which are unarguably persistent and bioaccumulative, and which provide the justification for the 'black list' or 'List I'. For such substances it is doubtful whether a threshold can be established between 'contamination' and 'pollution' (see paragraphs 1.11-1.12). We believe that the concept of a 'black list' is a reasonable one, which is consistent with the emphasis on preventive action in the Third Action Programme (paragraph 3.12), but that attention should now be given to reassessing the contents of that list. The United Kingdom cannot easily put its considerable experience in pollution control at the service of the Community as a whole if it continually places itself on the defensive. We would like to see the United Kingdom playing a positive and leading role in international forums, including the European Community, encouraging and formulating further measures for environmental protection. In pollution abatement, as in many other fields, there can also be commercial advantages for a country that is in the lead and has an anticipatory and continuous policy. We return to this theme in Chapter VI.

Best practicable environmental option

3.27 We drew attention in Chapter I to the shifting nature of pollution problems and the growing need for a co-ordinated approach which takes all the various pollution media, pathways and disposal routes into account. In the Fifth Report, 'Air Pollution Control: An Integrated Approach'(3), the Royal Commission introduced a new concept—that of 'best practicable environmental option' (BPEO)—and showed how it could be put into practice by certain changes in procedure and organisation.

3.28 The BPEO principle—which can be seen as a logical extension of BPM—had its origins in earlier Royal Commission thinking. In its Third Report(40), the Commission suggested, as the first part of a policy for estuaries, that 'control of pollution in estuaries must be part of a national integrated policy for waste disposal, which determines that waste shall be put where it will do least harm, not just where it is under least control'. As we discuss in Chapter IV, despite real progress since the publication of the Third Report many problems remain in connection with the disposal of waste materials in the estuarine, coastal and marine environments. Several of the major estuaries in the United Kingdom are still suffering severe ecological damage and many stretches of our coast have reduced amenity (paragraphs 4.52-4.71). We also note that there is a degree of scientific concern over the health of the North Sea, which is accompanied by international pressure to restrict further the discharge and dumping of sewage sludge and other waste materials (paragraphs 4.78- 4.101). Reductions in the disposal of waste materials to these environments usually mean increases in the quantities disposed of elsewhere. It is not a satisfactory policy to transfer disposal from one part of the environment to another without consideration of the comparative ecological and economic implications.

3.29 Other examples may be cited where an integrated approach is called for. Sulphur dioxide (SO_2) emissions can be reduced by limestone 'scrubbing' techniques; yet for every tonne of SO_2 captured, four tonnes of sulphated limestone require subsequent disposal. Domestic waste may be disposed of by incineration or dumping in landfill sites, with different environmental consequences. With contaminated land the question is whether the polluting material should be excavated and either reprocessed on site or removed, or whether it should be sealed where it lies. Energy policies (especially the issue of nuclear versus fossil fuel) carry important environmental implications, which call for a BPEO approach at a strategic level, for which we believe special institutional arrangements are necessary (paragraphs 5.133-5.144).

3.30 BPEO is also a crucial concept in developing the kind of approach to environmental protection which is outlined in the latest European Community Action Programme (paragraph 3.12). Many of the initiatives taken under the aegis of the programme, or through other international forums such as the Paris and Oslo Conventions (paragraphs 4.80-4.84), would display greater scientific and political credibility if the participants in negotiations sought to apply a more rigorous BPEO approach to the problems under discussion. BPEO is highly relevant to the growing emphasis on preventive and anticipatory, as opposed to remedial, action.

3.31 To give practical effect to BPEO, the Commission's 1976 Fifth Report proposed the creation of a new central pollution inspectorate ('HMPI'), answerable to the Secretary of State for the Environment (instead of the Health and Safety Commission), subsuming the existing Alkali Inspectorate and closely integrated with the activities of local authority environmental health departments. We consider that those recommendations have equal force today and we must therefore record our disappointment that the Government, in its eventual response to the Fifth Report(24), did not feel able to follow the Commission's advice. In particular, none of our latest findings appear to us to call into question the view expressed in the Fifth Report that the transfer of responsibility for the Alkali Inspectorate from DOE to the Health and Safety Executive was misconceived. By contrast, we are glad to note that the new Hazardous Waste Inspectorate, set up in response to the recommendations of the House of Lords Select Committee on Science and Technology (81), has been established within DOE.

3.32 Although we are pleased that the Government has generally endorsed the BPEO concept (which it acknowledges to be 'one of considerable power and utility'), we remain uneasy about how—in the absence of 'HMPI'—the concept is to be put into practice. As the Institution of Environmental Health Officers has put it, in its comments on the Government's response, 'the BPEO approach may become unworkable if it becomes no more than an excuse for increased liaison developing into an unwieldy and bureaucratic process not resulting in any significant improvements in the environment'. We share the misgivings of the Commission's former Chairman, Lord Ashby, in pointing out the weakness of a response in which the Government merely '*look to* all pollution control authorities to take account of the principles enunciated in the Royal Commission's report' (our italics) and 'will initiate' discussions on a report which had been on the table for nearly seven years(82). As a Minister commented shortly afterwards: 'It is too soon to say what will eventually emerge, but I have every confidence that a co-operative, pragmatic, cross-sectoral and preventive approach will see us through'(83). The danger, as we see it, is that such extreme open-mindedness and pragmatism may, in the absence of a more positive lead, generate much discussion but lead to little practical action.

3.33 Nevertheless, the Government has promised discussions, in particular as part of a comprehensive review of air pollution control legislation. We intend to follow the progress of this review closely, and we are glad to note that the Government's response keeps open the possibility of organisational change on the lines of the Royal Commission's original recommendations. We are concerned, however, that nearly a year after the response no consultation document has yet appeared. Progress on a draft circular on the application of BPEO also appears to be slow. We feel both matters should be tackled with much greater urgency. They should also be considered in the context of the wider questions relating to pollution control generally, which we discuss in paragraphs 3.47-3.50.

3.34 Meanwhile, we attach particular importance to strengthening the working relationships between the central Inspectorates and local environmental health departments. There has been considerable progress in this field since the Fifth Report, notably the growing number of local liaison committees on which members of the Industrial Air Pollution Inspectorate serve(50) and which we understand now take up between 5 and 10 per cent of the time spent by inspectors on visits. We remain concerned however that insufficient use is made of the expertise and 'front-line' position of environmental health officers (EHOs). We consider that the growing professionalism of EHOs, backed by technical qualifications and broadly-based experience, makes them all the more suited to undertake monitoring and enforcement duties in relation to certain works registered with IAPI, as recommended in the Fifth Report. We note that this is one of the issues to be considered in the Government's discussions and review; and whilst we are disappointed that progress could not have been made earlier, we understand that the Health and Safety Commission has authorised the Inspectorate to explore with the local authority associations the scope for extending the powers of local authorities to enforce industrial air pollution control under section 5 of the Health and Safety at Work etc. Act 1974.

3.35 In view of the Government's recent response to the Fifth Report and intention to review the whole field of air pollution legislation(24), we have not examined the subject in detail for the purposes of this study. In general we consider that the analysis and recommendations in the Fifth Report remain relevant to most of the problems that have been drawn to our attention. In particular we note the views which have been expressed to us by the Institution of Environmental Health Officers, the National Society for Clean Air, the Association of District Councils and several individual local authorities that the legal powers of local authorities are in many respects inadequate to deal with emissions from industrial processes (especially non-combustion processes), except where nuisance has already been caused. With the increased emphasis that European Community environmental policy now places on preventive action, it is clearly important that local authorities should have effective anticipatory powers in common with other pollution control authorities.

3.36 This last consideration is closely bound up with the wider question, on which the Commission has commented in earlier reports(3,5), of the interaction between pollution control and land use planning. Since we have not specifically sought evidence in this area, we do not propose to comment on the Government's response to the proposals in the Fifth Report which dealt with pollution and planning. We have, however, seen much incidental evidence which supports the view that pollution control is in practice not separable from development control and that many of the issues raised in the Fifth Report would merit further examination. For instance, it is normal for firms to hold confidential discussions with the Industrial Air Pollution Inspectorate about new developments which will come under their control. We consider it undesirable that these discussions should be conducted entirely separately from the discussions with local authorities about planning permission. All interested parties should in principle be involved at the outset. Central government advice to local authorities on this general question appears to be ambivalent and contradictory(84) and there is a need for more explicit guidance, and possibly a clarification of the law. In the air pollution field, at least, we hope that such clarification will emerge from the government's review. It is possible, too, that the proposed European Community Directive on the environmental assessment of development projects (paragraph 1.17) may have the effect of bringing pollution and development control practices closer together as far as major new projects are concerned.

3.37 We have drawn attention elsewhere to two specific areas where we believe local authorities' powers need to be strengthened. In Chapter V we recommend (paragraph 5.71) that local authorities should be provided with powers to act against excessive smoke emitted from diesel engines. In Chapter II we have drawn attention to the little use that is made of the discretionary powers in sections 79 and 80 of the Control of Pollution Act 1974 relating to local publicity about air pollution and have recommended (paragraph 2.78) that these powers should be made mandatory, that local authorities should make available annual reports of their pollution control activities, and that, as an interim measure, they should from now on be given positive encouragement to set up consultative committees under section 79. We believe that greater use of these powers will do much to enhance public confidence in the openness and fairness of pollution control. We also **recommend** that greater encouragement should be given to local authorities to pool resources in the use of manpower and equipment for pollution control. The Boroughs of Cleveland Pollution Control Group is a successful example of such co-operative working. If the Government's proposals for the abolition of the Greater London Council become law, a similar arrangement might help to ensure that the valuable expertise of the present GLC Scientific Services Branch continues to be at the disposal of London as a whole. We also see scope for more widespread collaboration between local authority environmental services departments and universities and polytechnics.

3.38 Whilst, therefore, we adhere to the proposals of the Fifth Report, which we see as essential to the successful operation of BPEO, we wish to record that an alternative proposal has been put to us by representatives of the Confederation of British Industry. This is that a high-level advisory body might be set up, under the auspices of the Department of the Environment, to consider and advise on cross-media issues of the kind which we have indicated in paragraphs 3.28–3.29. An advisory body of this kind would report to Government, and its membership would have to be of suitable stature and authority—with senior representatives from the Air Pollution and Factory Inspectorates and the water authorities, and experts on economics, land wastes and toxicology—if its views on control options, which could well involve concessions on the part of industry, regulatory agencies or both, were to prevail. Its status would be not unlike that of the former Commission on Energy and the Environment (see paragraph 5.140 *et seq.*); it would address itself only to major questions and would not be required to arbitrate on individual discharge or emission consents.

3.39 The case for this proposal depends on two factors. First it depends on the view that is taken on whether cross-media problems are on the increase or are likely to remain few and far between. We note that the Government takes the view(24) that 'there is probably not a large number of situations in which major choices exist in practice regarding the forms in which pollution arises; and there is little evidence that the present system is seriously failing in terms of achieving a sensible balance in the control of pollution of different forms'. We have, however, mentioned a number of examples in paragraphs 3.28–3.29 of situations which we believe merit serious consideration. Secondly, the CBI's proposal depends on the balance between BPEO questions which occur at a general or strategic level and those which arise in a local context. We would expect the latter to be more common than the Government's current view appears to allow for. Development of BPEO at the local level on a case by case basis—in the same way that BPM has been developed for over a century—would in our view be a more appropriate way forward. The arguments for and against the CBI's proposal therefore appear finely balanced. Nevertheless we **recommend** that the Confederation of British Industry's proposal for a high-level advisory body to consider cross-media pollution issues should be examined in detail by the Department of the Environment.

Checks and safeguards

3.40 Besides the formal executive arrangements at central and local government level which we have been discussing, there are other influences, some of them of a less formal nature, which help to shape and act as a spur to environmental protection. The influence of Parliament is, of course, particularly important and in recent years the House of Lords has developed a distinctive role in this field. Doubtless this can be attributed to the presence of special expertise in that House, including that of both past and present members of the Royal Commission, but it has also arisen naturally from the long timescale and relatively non-party-political nature of pollution problems, particularly in an international context. To this activity should now be added that of the European Parliament, whose influence on Community environment policy—as may be seen from recent developments over lead in petrol(85)—has been growing steadily.

3.41 Officially appointed advisory or 'watch-dog' bodies also play a very important part. We have already commented on the role of this Commission in Chapter I. We discuss the Commission on Energy and the Environment (CENE) in paragraphs 5.140-5.144. We were disappointed by the Government's decision to put CENE 'into abeyance' and, even more so, by the permanent winding up of two major consultative bodies in the environment field—the Clean Air Council and the Noise Advisory Council. We do not feel that the cases for their abolition have been justified.

3.42 In the area of radioactivity, we have followed with interest the work of the Radioactive Waste Management Advisory Committee (RWMAC), which was set up some five years ago in response to a recommendation in the Sixth Report(4). Within its field we consider the Committee has been successful in developing a comprehensive approach to radioactive waste management, and we support its efforts to promote better public understanding of the peculiarly emotive issues involved. We endorse the view in the Committee's Fourth Annual Report(33) that the absence of a standing independent advisory committee on the transport of nuclear materials, comparable to RWMAC itself and to the Advisory Committee on the Safety of Nuclear Installations (ACSNI), is an undesirable gap in the present arrangements. Transport of nuclear materials, particularly of spent fuel rods which are sent from nuclear power stations to Sellafield (Windscale) for reprocessing, has become a 'high profile' issue of late, as foreshadowed in the Royal Commission's Sixth Report, and accordingly, to restore public confidence, we **recommend** that the terms of reference of either the Radioactive Waste Management Advisory Committee or the Advisory Committee on the Safety of Nuclear Installations should be extended to cover the transport of nuclear materials.

3.43 Also in the radioactivity field, we have noted the announcement, in the Government's White Paper of July 1982 on Radioactive Waste Management(86), of the establishment of a Nuclear Industry Radioactive Waste Executive (NIREX), consisting of senior representatives of the United

Kingdom Atomic Energy Authority, British Nuclear Fuels Limited and the generating boards. This was in partial response to the Royal Commission's original recommendation in the Sixth Report that an independent statutory Nuclear Waste Disposal Corporation should be established. Since it is now official policy that heat-generating wastes of high-level radioactivity should be stored centrally at Sellafield for at least fifty years before eventual disposal, the principal concern of the disposal authority during the coming years will be with intermediate-level wastes: hence it is argued that less formal arrangements (which leave responsibility with the nuclear industry and avoid the need for legislation) will be adequate.

3.44 Nevertheless RWMAC, whilst endorsing the Government's decision on NIREX, has commented that 'it is reasonable to suppose that, as the activities of NIREX expand, its structure may also undergo a process of evolution to meet the increased demands placed upon it', and has declared its intention to monitor NIREX's progress and to provide 'an informed, independent and public critique of its activities'(33). We believe this public monitoring task is most important, and we do not accept the criticism that RWMAC's ability to monitor NIREX objectively is compromised by some overlapping membership. Given the overall balance in its membership and the independent status of its Chairman, we are satisfied that RWMAC is properly constituted for its task. We believe, however, that its effectiveness would be enhanced if its membership were enlarged to include suitable expertise from local government; for local authorities are heavily involved in the task of finding suitable land-based sites for waste disposal. We therefore **recommend** that the Radioactive Waste Management Advisory Committee's membership should be enlarged to include people with local government experience.

3.45 We are inclined to share the doubts which have been expressed (although discounted by RWMAC)(33) as to whether NIREX can command full public support when its membership is wholly confined to the nuclear power industry. We also believe that the wider public interest should be explicitly reflected in NIREX's membership, which is at present wholly confined to persons who have a direct concern with the success of the nuclear industry. Such a requirement would in no way conflict with NIREX's role as an executive body, which distinguishes it from the purely advisory role played by RWMAC. The practice of appointing outside non-executive directors, as representatives of wider interests of shareholders or the community, is commonplace in both private and nationalised industry. We note the view of RWMAC(33) that appointment of independent members to NIREX could be regarded as compromising the Secretary of State for the Environment's impartiality in considering proposals put forward by NIREX. We are not aware that this is generally regarded as a problem in the Government's dealings with the nationalised industries (to which all appointments at board level are made or approved by Ministers). Accordingly we **recommend** that the board of the Nuclear Industry Radioactive Waste Executive should be enlarged to include independent members, appointed by the Secretary of State for the Environment, who are able to speak from a knowledge of wider public concern and to contribute suitable scientific and environmental expertise.

3.46 Non-governmental and voluntary activities serve both to underpin and to challenge the activities of official bodies. The leading professional and academic institutions, which have contributed much to the thinking behind this report, have a significant part to play in the development of environmental policy, as do major interest groups like the CBI and the TUC. But in parallel to their activities, a healthy and vigorous voluntary sector is essential to informed public debate and decision-taking. We have already noted, in Chapter I, the strong growth of 'environmentalist' opinion which has characterised the past decade. It has now assumed international dimensions, through the activities of many and diverse groups such as Greenpeace, Friends of the Earth, the European Environmental Bureau (EEB) and the Bureau Européen des Unions de Consommateurs (BEUC). We endorse the European Commission's policy of support for non-governmental organisations working in the environment field ([19]): voluntary bodies can perform an important service by mobilising public opinion (see paragraphs 1.20-1.22 and 2.26 *et seq.*).

The environment and the law

3.47 Membership of the European Community has stimulated discussion about the adequacy or otherwise of the United Kingdom's environmental legislation in the Community context. We have not directly studied this complex field and can therefore offer only broad comments, together with a few specific points that have been drawn to our attention. We have already commented (paragraph 3.4) on the characteristics of our domestic legislation which tend to make it seem imprecise and untidy to continental legislators. The 'compliance notices' which the Government provides to the European Commission, reporting on how directives have been implemented, frequently consist of references to local pollution control authorities' *powers* to act and to the various guidance circulars issued to them by central government. The apparent absence of a *duty* to enforce controls is not always readily understood.

3.48 We foresee growing pressure, without necessarily passing judgment on its merits, for greater use of statutory measures, to ensure effective implementation of European Community requirements, in place of the United Kingdom's traditional emphasis on extra-statutory procedures, voluntary codes of practice, 'government by circular' and the like. For instance, the non-statutory Pesticides Safety Precautions Scheme (PSPS) depends for its effectiveness on the voluntary co-operation of the agrochemicals industry and their distributors in the British Agrochemical Supply Industry Scheme (BASIS), the purpose of which is to ensure that only products which have received PSPS clearance are supplied and marketed in the United Kingdom. In the past two years these arrangements, which were welcomed by the Commission in its Seventh Report([5]), have run into difficulties. The Commission of the European Communities has expressed the view that the trade agreements which underlie BASIS may be contrary to the free trade principles of the common market. At the same time the British Agrochemicals Association has been pressing the Government to introduce regulations to make it an offence to import, sell, supply or use products not cleared under the Scheme(87,88). These recent developments are unrelated to, though perhaps emphasise the importance of, the recommendation in the Seventh Report that the PSPS should be given statutory recognition.

3.49 Pollution control law in the United Kingdom is diffuse, uncodified and (in the case of much of the Control of Pollution Act 1974) obscure to all but the expert practitioner. There is a temptation to recommend its simplification and consolidation into one Act, or at any rate its grouping on some logical basis. This is, of course, a question which the Law Commission would automatically keep under review, without looking to this Commission for advice. We would however offer the comment that if (as we have seen earlier) the objective is to integrate environmental considerations into all areas of activity, any move to segregate the law relating to the environment might tend to contradict that philosophy.

3.50 We should also like to draw attention to a legislative problem which extends beyond the field of environmental pollution. The piecemeal and still incomplete(89) implementation of the Control of Pollution Act 1974 is only one example of 'optional' legislation, where ministers' unfettered discretion over commencement dates can effectively frustrate Parliament's intentions. It is, of course, for Parliament to ensure that future legislation does not fall into the same mould. Nevertheless the handling of this Act reflects little credit on successive administrations, and as we note in Chapter IV it is only pressure from the European Community that has finally led to a partial implementation of Part II of the Act.

The directing of environmental policy

3.51 Overall co-ordination of policy on environmental pollution in the United Kingdom is the responsibility of the Department of the Environment. The Department embraces a much wider range of functions than its name would imply and the Secretary of State holds certain major responsibilities (notably for housing and local government) which tend to place heavy demands on his time and may divert him from the increasingly important task of ensuring that environmental considerations are integrated into all areas of government policy. It is therefore important that within the Department the component which is concerned with environmental protection *per se* should be given adequate resources and status. The Central Directorate of Environmental Protection (CDEP) (until recently titled the Central Directorate on Environmental Pollution) has the task of co-ordinating policy within DOE and interdepartmentally. We have found that CDEP, as now constituted, lacks the distinctive status and stature of its precursor, the Central Unit on Environmental Pollution (CUEP), which was originally established in the Cabinet Office at the same time as the establishment of the Royal Commission but was later transferred to DOE. It is difficult to pinpoint our precise areas of concern, and we hesitate to pronounce on matters of organisation or staffing. It does appear to us, however, that CDEP has been required to operate for some time on too slender a basis and that its effectiveness as a central source of advice on

United Kingdom environmental policy has suffered. We also feel that its contacts with pollution control authorities in the field, particularly in local government, are insufficiently close and that it would benefit from more direct links, which the presence of staff with a background of relevant experience (for example as environmental health officers) would help to provide. Finally, we believe that the pursuit by DOE of a consistent and co-ordinated environmental policy is made more difficult by the fact that water pollution policy—arguably the most important of DOE's concerns in the environmental field—falls for organisational reasons under a different chain of command from that of CDEP; and in Chapter IV we indicate some grounds for concern that the demise of the National Water Council may place the Department under strain (paragraph 4.50).

3.52 Recently the Department published its first Annual Report, for 1982–83(90). Assuming that this becomes the first of a series, we believe it will help to focus Parliamentary and public attention on the Department's aims and objectives, and on its success in achieving them. The Department's key objectives in the environmental protection field, as set out in the Report, are as follows:

DEPARTMENT OF THE ENVIRONMENT: KEY OBJECTIVES

Environmental protection

To prevent damage to the environment and its ecological systems on which man depends

To improve the quality of the environment and eliminate the scars of past pollution

To dispose of wastes of all kinds in an acceptable way

Water services

To sustain water undertakings in providing a high standard of water services, including the control of pollution, and to encourage them to improve their efficiency

3.53 Royal Commissions, like any other advisory bodies, must accept the fact that not all of their recommendations will be implemented. However, it is reasonable for them to expect that their reports will be dealt with as expeditiously as the complexity of the subject matter permits. Unfortunately in our case these expectations have not always been met. We have already referred (in paragraphs 3.31–3.32) to the much delayed response to the Fifth Report and to the fact that on some issues it does little more than initiate discussions which could have begun several years previously. By contrast the first three reports and the Sixth Report were acted upon promptly. We are aware that the 1979 Seventh Report (like the Fifth Report) raised difficult issues for successive governments. Nevertheless it was disappointing that, as we signed this Report, no response had yet emerged when as long ago as September 1981 a member of the present Government had been quoted as saying: 'We are at the moment finalising our response to the Commission's report on agricultural pollution'(91). By the end of 1982 the target for publication had been revised to 'early in 1983'(92). A response was still awaited on the 1981 Eighth Report, too, despite our being led to understand on several occasions over the past year(93) that it was virtually in its final form*. We have, however, already mentioned (paragraph 1.4) the Government's swift response to the Ninth Report, on lead in the environment. The nature of this response gives us grounds for optimism that the Royal Commission's role as an independent watch-dog body, transcending departmental boundaries, will continue to be of value to successive administrations. In Chapter VI we set out our proposals for future work.

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*The Government's responses to the Eighth and Seventh Reports were published respectively on 19 and 20 December 1983 as DOE Pollution Papers 20 and 21(94).

CHAPTER IV

WATER QUALITY AROUND THE COAST

> *Seas but join the regions they divide.*
>
> Pope, *Windsor Forest*

Introduction

4.1 Having discussed in general terms the nature of pollution and current priorities (Chapter I), the influences of public attitudes on policy making (Chapter II) and developments in the institutional framework available for securing effective environmental protection (Chapter III), we now seek to illustrate how these influences and developments are operating in two environmental sectors: estuarine, coastal and marine waters, and the atmosphere. These are not only sectors in which our preliminary survey (see paragraph 2.3) confirmed public concern to be strong but they are also ones that the Commission has previously examined in some detail, in the Third (40) and Fifth(3) Reports respectively. Against the background of those reports, and in the light of recent scientific knowledge, we review developments and current issues in the protection of estuarine, coastal and marine waters in this chapter and issues of atmospheric pollution in Chapter V.

4.2 The Commission's Third Report(40), published in September 1972, included a recommendation for urgent action to arrest the growing volume of toxic pollutants, many of them not subject to control, which were finding their way into British estuaries and coastal waters, either from rivers or from direct discharges. The Report recommended the adoption of a specific policy for estuaries to meet this problem, with the following components:

—integration of pollution control of estuaries within a national policy for all waste disposal that would minimise harm to the environment;

—maximum practical abatement from effluents before discharge of all pollutants unlikely to be rendered harmless by natural processes;

—unification of executive responsibility for controlling pollution in estuaries;

—adoption of two simple biological criteria for the management of estuarine waters:

  - ability to support the fauna essential for sustaining sea fisheries, and
  - ability to allow the passage of migratory fish at all states of the tide.

We comment on the relevance of the last two of these targets to present-day conditions in paragraph 4.22 below.

4.3 The Third Report also made a series of detailed recommendations for reforming the law and administrative arrangements, for improving the quality of monitoring, and for research. It emphasised the contribution that agreements and action at an international level could make towards abatement of pollution in the seas around the coast of Great Britain, particularly the North Sea.

4.4 The Commission's Fourth Report(2), published in December 1974, reiterated concern about the state of many estuaries. However, it also recorded that 'the main recommendations in (the Third) Report that called for action by the Government have been incorporated in the Control of Pollution Act'. That Act received the Royal Assent in July 1974 yet nine years later the majority of its key provisions for improved control of water pollution (Part II of the Act) remain inactive on the statute book and the latest plans for bringing them into effect(95) involve a phased programme that will not be completed until mid-1986, some 14 years after the Commission made its original recommendations. We note with interest that provisions comparable to those in Part II of the Act are contained in the Water Act (Northern Ireland) 1972 and that that Act was brought into effect immediately.

4.5 We recognise that the main reason for the delay in implementing Part II of the Act has been concern that the new provisions would impose additional costs on industry and public authorities. Whether the repeated postponement of these desirable reforms has been in the best long-term interests of either the parties concerned or the environment is debatable. In our Ninth Report(7), we pointed out that industry may well prefer the certainty of change, even when it may increase costs, to continuing indecision or revision of plans. Now that implementation seems at last to be in prospect, it is useful to review the implications for estuarine and coastal water quality and the resources that will be required to make the new arrangements work effectively.

ESTUARIES AND COASTAL WATERS IN BRITAIN

Special characteristics of estuaries

4.6 Estuaries are very complicated systems. In the upper reaches, freshwater plants and animals are progressively eliminated, depending on their tolerance of the increased salinity of the water. At the seaward end, marine plants and animals penetrate upstream to the extent that they can tolerate dilution of the seawater by freshwater. But the middle reaches are the most arduous because of the widely fluctuating conditions resulting from the tidal regime. Here the fauna and flora are restricted to a few species, but the nutrient input is high and those species which do occur can be present in great abundance. Because of their richness, the lower reaches of estuaries support valuable shellfish fisheries, act as important nursery grounds for fish and are feeding grounds for vast flocks of birds. Economically important fish, such as salmon and eels, pass through estuaries on their migrations. At the interface between saltwater and freshwater there is flocculation and precipitation of much of the sediment carried in the river. Chemical pollutants may be modified or adsorbed on to the particulate matter and carried to the bottom. Whether adsorbed on solids or in solution, the distribution of such materials over mud flats, shallows and marshes is strongly influenced by currents, tides and winds.

4.7 Thus, estuaries are ecologically diverse and their response to discharges of waste and other alien matter is particularly complex and not wholly predictable. As we mentioned in paragraph 3.14, the view that the United Kingdom can rely on the ability of estuarine and coastal waters to act as relatively cheap and convenient sites for the disposal of much industrial and domestic waste—a charge sometimes made by other countries, for example within the European Community, where practices and opportunities differ—is being increasingly challenged. The recreational use of estuaries and coastal waters is also of growing importance, and public pressure demands continuing improvements to water quality beyond the point at which the immediate causes of chemical and biological harm are abated. However, as the Commission's Third Report pointed out, the substantial costs of successive improvements must be set against the value, much of which is intangible, of the benefits they bring. It is therefore important not only that the United Kingdom's pollution control machinery is demonstrably capable of safeguarding the integrity and diversity of estuarine ecology but also that the machinery is operated openly in pursuit of a balance between commercial and environmental objectives that is appreciated and, so far as possible, approved by the public.

Estuarine water quality in England and Wales

4.8 In the Third Report(40) the Commission commented that 'it might be up to ten years before estuaries reap the full benefit from reformed controls. In our view this time-lag would be dangerously long'. The time needed for the physical and biological health of estuaries to improve, once the worst sources of pollution were abated, was seen as a less significant cause of delay than the potentially disruptive effects of impending reorganisations of both local government and the water industry in England and Wales and the generous periods of grace which seemed likely to be granted before dischargers, including the water industry itself, were required to comply with tighter controls. The effect of the reorganisations in 1974 has long since passed—indeed, further though less fundamental changes to the organisation of the water industry were introduced in 1983 (see paragraph 4.41) and changes in the organisation of local government (the abolition of the Metropolitan County and Greater London Councils) are again in prospect(96). Periods of grace, of currently unspecified duration, are only now coming formally into effect (see paragraph 4.33).

4.9 The Third Report recorded the hope that, to counter the effects of the delays that could be foreseen even in 1972, local and water authorities would make maximum use of existing powers to deal with the worst estuarine problems and that industry would not wait for new legislation before making its own contribution. In the event, some of the grosser sources of pollution have, as a result of the world-wide recession and of structural change in industry, declined for reasons quite unconnected with pollution control; and water authorities, with the general co-operation of industry, have done much to ensure that the problems that the Commission identified in 1972 as particularly urgent have not worsened over the past decade—indeed, they have shown a gradual lessening. But a return to economic growth may presage an increase in pollution from traditional industries unable to invest in suitable control equipment(50), and new industries can bring with them new forms of pollution. Moreover, knowledge of the sub-lethal effects of pollution is improving all the time. The need for a proper legislative and administrative framework, capable of responding to and, as far as possible, anticipating problems swiftly and efficiently, therefore remains as great as ever.

4.10 Trends in the quality of estuarine and tidal waters in England and Wales have been monitored by a series of comprehensive surveys. The 1970 river pollution survey(97), some results from which were quoted in the Commission's Third Report to emphasise that there was no ground for complacency over the state of tidal rivers, was organised by the Department of the Environment, who updated it in 1971 and 1972 and undertook a further major survey in 1975(98). The most recent river quality survey was undertaken in 1980 under the auspices of the National Water Council(99). The surveys show substantial reduction since 1970 in the length of tidal rivers classified as poor or grossly polluted. Improvements were particularly marked in the period between 1975 and 1980. Overall changes in quality between the 1970 and 1980 surveys are summarised in Table 4.1, and the net quality changes between the 1975 and 1980 surveys in each of the water authority areas are shown in Table 4.2.

4.11 Total changes in quality are much greater than net changes since much of the upgrading is offset by downgrading, particularly between the 'doubtful' and 'poor' categories, and overall the quality of one third of the total length of tidal rivers in England and Wales changed, for better or worse, between 1970 and 1980. However, a greater length has been upgraded than downgraded,

Table 4.1

Tidal river quality in England and Wales, 1970–80

Classification	*Length in 1970 Survey*		*Length in 1975 Survey*		*Length in 1980 Survey*	
	km	*%*	*km*	*%*	*km*	*%*
1 Unpolluted	1,387	48.1	1,422	49.6	1,409	50.3
2 Doubtful, needing improvement	675	23.4	720	25.1	948	33.9
3 Poor, urgently needing improvement	485	16.8	424	14.8	222	7.9
4 Grossly polluted	336	11.7	301	10.5	220	7.9
Total	2,884	100.0	2,866	100.0	2,799	100.0

Source: Reference(99)

Table 4.2

Net change in tidal river quality by water authority area, 1975–80

Water Authority	*Classification* *1* *unpolluted* *km*	 *2* *doubtful* *km*	 *3* *poor* *km*	 *4* *grossly polluted* *km*
North West	+4	+1	+7	−12
Northumbrian	+10	+1	−9	−2
Severn Trent	0	+42	−42	0
Yorkshire	0	0	0	0
Anglian	+3	+22	−25	0
Thames	−1	+50	−49	0
Southern	+30	−28	+2	−4
Wessex	+7	+35	−13	−29
South West	+13	+4	−17	0
Welsh	−9	+38	−28	−1
Total	+57	+165	−174	−48

Source: Reference(99)

both in aggregate and in most individual water authority areas. The principal reasons for improvements in water quality are the closure of unsatisfactory sewage works and investment in new and enlarged treatment works and trunk sewers to serve them. It is estimated(100) that over 50 per cent of the polluting load carried by sewers to disposal works that discharge to tidal waters is now removed by treatment before disposal, and an increasing proportion of the remainder is discharged through long outfalls, increasing the opportunity for its dilution and dispersion and making its accumulation to polluting concentrations unlikely. Other reasons for water quality improvements include determined attempts to clear 'black spots', the increased use of sewers rather than direct discharge for polluting trade effluents, investment by industry in waste water treatment plant, and the decline of industrial production. The causes of deterioration in the quality of estuarine and tidal waters are more varied, though deferment of investment and the consequent increase in inadequate treatment, overloading and failure of ageing sewage works are major factors. The lack of full statutory controls could, of course, also be a further, unquantifiable factor. Moreover, although very local or short-lived pollution cannot be recorded by a periodic water quality survey, specific pollution incidents such as escapes of farm wastes can downgrade water quality for considerable periods and so are reflected in the survey results.

4.12 A feature of the 1980 river quality survey(99) was the new estuary classification system designed to give a more objective assessment than the former system, which applied to all rivers, whether tidal or not. The new system allocates scores according to specified features of biological, aesthetic and chemical quality—including the ability to allow the passage of those migratory fish which can be supported by the freshwater reaches of the estuary and to support a fish population characteristic of the natural physical and hydrographic conditions of the estuary (see paragraph 4.2). The aggregate scores are graded in four bands defining the estuary classes. The results of the new classification, which are not comparable with those from earlier surveys, are given in Table 4.3.

Table 4.3

Estuarine water quality in England and Wales by water authority area, 1980

Water Authority	*Classification*								*Total*
	A *good*		*B* *fair*		*C* *poor*		*D* *bad*		
	km	*%*	*km*	*%*	*km*	*%*	*km*	*%*	*km*
North West	220	49	90	20	71	16	69	15	450
Northumbrian	41	31	43	32	7	5	43	32	134
Severn Trent	11	13	72	87	0	0	0	0	83
Yorkshire	5	13	17	42	18	45	0	0	40
Anglian	453	88	52	10	7	1	2	0	514
Thames	49	36	89	64	0	0	0	0	138
Southern	307	81	60	16	13	3	0	0	380
Wessex	44	41	50	46	14	13	0	0	108
South West	330	94	17	5	2	1	0	0	349
Welsh	321	78	89	21	4	1	0	0	414
Shared estuaries:									
Humber	29	46	34	54	0	0	0	0	63
Severn	18	37	28	57	0	0	0	0	46
Total	1,828	67	641	24	136	5	114	4	2,719

Source: Reference(99)

4.13 Some comment on the future of the river and estuary classification schemes and the river quality survey is appropriate. The surveys undertaken to date represent a substantial investment in the recording of water quality in British rivers and estuaries since 1960; their technical aspects have been refined over the years and their findings are generally considered authoritative; and the continuity of successive surveys and consequent identification of trends are invaluable in demonstrating to the public and to those with a professional concern for the environment (including ourselves) where progress has been made and where problems remain. We are therefore concerned about the future of the survey in the light of the decisions, which took effect from 1 October 1983, to streamline the operation of the water industry and, in particular, to abolish the National Water Council. We note that the Department of the Environment proposes to resume responsibility for the survey and that the next survey is being planned for 1985. We urge the Department to ensure that the quality, coverage and continuity of the survey are maintained.

The Mersey, Tyne, Tees and Thames estuaries

4.14 As the data we quote above from past surveys show, the broad picture which emerges is one of general improvements to estuaries and to the rivers which feed them, but with some black spots remaining. We do not propose in this Report to catalogue the condition of each individual estuary, but there are some which we consider call for particular comment—the Mersey, the Tyne and the Tees (all of which we have visited) and the Thames.

4.15 Of the remaining estuarine black spots, the Mersey, which we visited in June 1982, stands out as the worst example. The estuary currently receives, untreated, the domestic sewage, trade effluent and surface water run-off from the Liverpool and Wirral conurbations. With a population of almost 1½ million, they comprise by far the largest urban area in the United Kingdom with untreated discharges. There are nearly 50 outfalls in the lower part of the estuary alone and upstream there are further heavy polluting loads from Warrington, Runcorn, Widnes and Ellesmere Port. The Manchester Ship Canal and the River Weaver add smaller, though substantial, loads. The result is that the banks of the estuary are polluted with offensive solids and that the water suffers a serious oxygen deficiency which can cause smell and, together with persistent and sometimes toxic industrial effluents, markedly restricts the ability of the estuary to support aquatic life(101).

4.16 In November 1982, as part of the Government's special Merseyside initiatives, the Department of the Environment issued a consultation paper(101) examining the extent and nature of existing problems throughout the Mersey catchment area, the improvements that the North West Water Authority had already achieved by investment in improved sewerage and sewage treatment works, the scope for controlling the older and hitherto uncontrolled discharges to the estuary once the relevant provisions of the Control of Pollution Act were implemented (see paragraph 4.30), the role that the private and voluntary sectors as well as public authorities might play in the revitalisation process, and likely costs and timescales. The consultation paper was discussed at a conference in March 1983 and agreement was reached on the development by the Department of the Environment of outline proposals for action for submission to the local authorities concerned. In adding our support to this initiative we would stress the need for steady funding to ensure that long-term plans and priorities are not upset by short-term financial expediency. To encourage debate on the plans and priorities to be set, not only for the Mersey itself but also throughout the region, the North West Water Authority issued a consultation document in September 1983(102) inviting comments on a strategy for water quality improvements over a 25 year period and involving investment by the Water Authority alone of some £3,700 million. Amongst the objectives suggested were that the highest priority should be to avoid deterioration of existing water quality and that improvements to the worst polluted rivers and estuaries should take priority over further improvement to other waters. These priorities are comparable to ones we suggest later in this chapter (see paragraph 4.22).

4.17 During our visit to north east England in March 1982 the Northumbrian Water Authority drew our attention to the still unsatisfactory water quality of the tidal parts of the Rivers Tyne and Tees. The tidal part of the Tees receives discharges of industrial effluent and raw sewage, though in the last decade there have been significant reductions in industrial effluents due largely to improvements undertaken by the industries themselves. The water authority, in consultation with industry and the public, has developed a series of targets for further improvements to the Tees estuary when resources permit: the first target is for the elimination of smells and nuisances, the second to allow the passage of young salmon from freshwater to the sea in spring, and the third to allow the passage of migratory fish at all time. The successive costs of meeting each target were estimated, at 1980 prices, to be £30 million, £50 million and £150 million respectively, with a proportion of these costs to be met by industry (mainly by Imperial Chemical Industries).

4.18 Until recently large stretches of the Tyne also suffered from high levels of pollution, concentrated in the estuaries and downstream reaches of the river. The main sources were riverside discharges of crude sewage and industrial process water. However, the construction by the Northumbrian Water Authority of new sewers for trade effluent and sewage treatment plants along the rivers has improved water quality considerably. The interception of sewage on the Tyne has now progressed from the mouth of the estuary to the Tyne Bridge. In addition to the visual benefit from the removal of sewage solids, there has been a marked improvement in chemical and biological water quality in the stretch of the estuary from Felling to Jarrow.

4.19 The Commission's First Report(1) referred to improvements already brought about in the condition of the Thames estuary and noted how the estuary provided an excellent example of the use of a scientific study to pinpoint the action required to reduce pollution. Improvements have continued in the last decade: for example in 1972, over 80 per cent of the length of the tidal Thames was classified as 'poor' by the river pollution survey (see paragraph 4.10) while only 17 per cent was classified even as 'doubtful' and none was 'unpolluted'; however, by 1980, over 83 per cent could be classified as 'doubtful' (a term regarded as not wholly appropriate since it is intended to describe water suitable for potable supply after advanced treatment, supporting reasonably good coarse fisheries and with moderate amenity value—see Plate 2) and 16 per cent had reached the top 'unpolluted' category. Further evidence of improvements is provided by the number of fish species recorded in the estuary, which has risen from 1 in 1963 to 65 in 1972 and to 101 in 1982; two salmon were caught in 1983. The number and variety of macroinvertebrate species found have also increased and clearly pollution is no longer a barrier to the movement of migratory species in the tidal river(103). These improvements have been due to major extensions to sewage works (Plate 3) and a reduction in the polluting loads discharged by industry of over 50 per cent between 1970 and 1980. Overall, the Thames Water Authority justifiably claims that 'the condition of the tidal river has now been substantially restored and is stable.'

Estuarine water quality in Scotland

4.20 The Commission's Third Report, published in 1972, referred to the water quality problems in the Clyde, Forth and Tay estuaries. Over the last decade there have been improvements in all three estuaries, due mainly to improvements made by regional councils to sewerage and sewage treatment facilities for effluents discharged directly to tidal waters. The effects of trade effluents discharged to tidal waters have also been reduced, mainly by relocating outfalls to achieve better dispersion of the effluent and so reduce acute toxic effects in shallower inshore waters. The load of industrial effluent being discharged to tidal waters has also fallen significantly. Major new sewerage and sewage treatment works have been commissioned in the tidal reaches of the Tay and on the Forth at Seafield, near Edinburgh, greatly improving the amenity value of nearby beaches. Indeed, the Tay is now used by research groups from several Western European countries as a benchmark for river cleanliness. Improvements to sewage treatment works in Glasgow should improve water quality in the Clyde estuary to the point where it should be capable of meeting the Commission's two basic estuarine biological objectives for most of the time (see paragraph 4.2)(104).

4.21 In their evidence to us, the Scottish River Purification Boards' Association suggested that if the three major improvement schemes mentioned above had not been started in the early 1970s, they would probably have been affected by cuts in public expenditure and that present constraints would not allow them to proceed, although we note that other major schemes, for example a new outfall at Aberdeen, have been commissioned recently even under existing financial constraints. However, as the Association also pointed out, since most of the existing pollution in Scottish estuarine and coastal waters is attributable to unsatisfactory sewerage and sewage treatment facilities, the pace of future improvements to water quality will be largely determined by the availability of funds for investment in treatment works by Regional and Island Councils.

Remaining problems

4.22 We have drawn attention above (paragraph 4.11) to the fact that, in present economic circumstances, the shortage of funds for investment by water and local authorities in new and improved sewage treatment works was the main reason for increases in and the continued presence of estuarine waters of low quality. The view that finance, rather than legal powers, is the principal key to further progress was held by many of those from whom we received evidence. When money is limited, we feel it is better to concentrate on improving stretches of the most polluted rivers and estuaries rather than to devote resources to raising a second class stretch of river or estuary to the top class. However desirable the latter objective may be, aesthetically and ecologically, deferment is probably the least painful option. Not only does the ratio of benefits to costs decline with each successive tranche of expenditure, but concentration of resources on the worst problems in each area will bring about more conspicuous and durable improvements than would be achieved by spreading expenditure more thinly on marginal and potentially reversible improvements over greater lengths of rivers and estuaries. In present economic circumstances we believe that the attainment of the biological criteria proposed in the Commission's Third Report (see paragraph 4.2) should take a lower priority than tackling the worst problems.

4.23 Besides the improvements in the quality of estuarine waters over the last decade, we are also encouraged by the general quality of water around the coastline. The Ministry of Agriculture, Fisheries and Food considers(88) that at present there is no significant threat from pollution to fisheries within the three mile band for which water authorities will be assuming responsibility when the relevant provisions of the Control of Pollution Act are brought into force (see paragraph 4.30). Nevertheless there remain localised problems (some of them serious) of inadequate sewage disposal arrangements resulting in contamination of beaches and shellfish grounds. We consider these further in paragraph 4.53 *et seq.* and 4.73 *et seq.* respectively. We also share the concern expressed in the Commission's Third Report about the possible long-term effects of accumulations of pollutants from dumping, land-based discharges and atmospheric deposition in the North Sea. We discuss this further in paragraph 4.79 *et seq.*

THE CONTROL OF POLLUTION ACT 1974

4.24 When the Bill that eventually became the Control of Pollution Act 1974 was debated in the House of Commons, the then opposition spokesman (the Rt Hon Mrs Margaret Thatcher MP) claimed that it represented 'the most comprehensive attempt for many years to bring pollution under control. It may be couched in dull phraseology, but it is likely to have a greater and more lasting effect of the quality of life in many parts of Britain than most other measures'(105). So far as the majority of the Act's provisions relating to water pollution are concerned, that claim remains to be tested. In the earlier section of this chapter we illustrated some of the changes, generally for the better, that have occurred in the last decade without the direct benefit of those provisions, though to some extent in anticipation of them, and despite increasing pressure on public expenditure and industrial investment. In this section we attempt to judge whether, now that implementation of the major elements of Part II of the Act (COPA II) is in prospect, the same claim can validly be made today.

4.25 The Act is indeed comprehensive. It includes provisions for dealing with waste on land, pollution of water, noise, pollution of the atmosphere and miscellaneous other issues. By 1 October 1983, 87 of the Act's 109 sections were wholly or partly in force. Of the 22 sections not in force, even partially, 20 (out of a total of 26 in the Act) were concerned with the pollution of water; the other two concerned waste on land. A very rough guide to the rate of implementation of the Act as a whole can be seen from the pattern of Commencement Orders issued: seven in the period 1974–76; a total of six in 1977 and 1978; and one in each of the years 1981, 1982 and 1983.

4.26 Part II of the Act spans sections 31 to 56 (see box for details). Sections 43 and 44, which apply to England and Wales only, were the first to be implemented, in December 1974 (SI 1974, No. 2039). They withdrew the exemptions that were granted to some existing discharges of trade effluent when the Public Health (Drainage of Trade Premises) Act 1937 was passed and thus brought all discharges of trade effluent to public sewers in England and Wales under the control of water authorities. The Commission, in the Third Report, welcomed the Government's intention to enact this provision. However, the associated provision in section 45 of the Act, which also applies to England and Wales only and which would empower a water authority to vary the conditions for the reception of trade effluent discharges less than two years after the setting of these conditions if it considers such a variation necessary to protect persons likely to be affected by a discharge, and provided it pays compensation when appropriate, has not yet been brought into effect.

4.27 Sections 49 and 50 were the next to be implemented, in England and Wales only, with effect from January 1976 (SI 1975, No. 2118). Section 49 makes it an offence for any person, without the permission of the water authority, to disturb stream sediments so that they are carried downstream or to cut or uproot any substantial amount of vegetation which is then left lying in the water. Section 50 empowers water authorities to investigate actual and potential water pollution arising from the abandonment of mines. Both these minor provisions will, when implemented, apply in Scotland, where the River Purification Boards and Island Councils are the responsible authorities, as well as in England and Wales. Section 56, governing the interpretation of COPA II, was also bought into effect, in England and Wales only, from January 1976 (SI 1975, No. 2118).

4.28 In April 1978 the Government announced that, reluctantly, the implementation of the remaining, major provisions of COPA II would be delayed(106). It was thought that their implementation would place water authorities in a position where they would have to incur substantial capital expenditure on new and improved sewage treatment works, at a time of increasingly severe restrictions on public expenditure and of great public pressure to minimise their charges. Industry, also under severe economic pressure, would be similarly affected. Nevertheless, the Government did restate its commitment to making the administration of pollution control as open as possible and announced that it had decided to implement the remaining provisions of COPA II in England and Wales by the end of 1979. In June and July 1978 the Department of the Environment issued consultation letters seeking comments on a proposed two-stage implementation process to be completed by that date. In the event, the process never got under way because the General Election of May 1979 intervened.

4.29 The new administration in 1979 introduced further restrictions on public expenditure, including cuts of about 11 per cent in water authorities' budgets for 1979–80 and in their projected expenditure for 1980–81. The water authorities, whilst remaining committed to the requirements of the Act,

Contents of Part II of the Control of Pollution Act 1974
Pollution of Water

Section of Act	Subject
	Control of entry of polluting matter and effluents into water
31	Control of pollution of rivers and coastal waters etc.
32	Control of discharges of trade and sewage effluent etc. into rivers and coastal waters etc.
33	Control of sanitary appliances on vessels.
	Consents for discharges
34	Consents for discharges of trade and sewage effluent etc.
35	Reference to the Secretary of State of certain applications for consents.
36	Provisions supplementary to sections 34 and 35.
37	Revocation of consents and alteration and imposition of conditions.
38	Restriction on variation and revocation of consent and of previous variation.
39	Appeals to the Secretary of State.
40	Transitional provisions relating to consents.
	Ancillary provisions relating to control of discharges
41	Registers.
42	Power of Secretary of State to exempt applications, consents and conditions etc. from publicity.
	Control of discharges of trade effluent into public sewers
43	Control of discharges into sewers.
44	Provisions supplementary to section 43.
45	Early variation of conditions of discharges.
	Miscellaneous
46	Operations by water authorities to remedy or forestall pollution of water.
47	Duty of water authorities to deal with waste from vessels etc.
48	Power of water authorities to exclude unregistered vessels from rivers etc.
49	Deposits and vegetation in rivers etc.
50	Investigation of water pollution problems arising from closure of mines.
51	Notice to abstain from certain agricultural practices.
52	Charges in respect of certain discharges in England and Wales.
53	Charges in respect of certain discharges in Scotland.
54	Exclusion of certain liability in respect of discharges etc. with consent.
	Supplemental
55	Discharges by water authorities.
56	Interpretation etc. of Part II.

All sections apply to Great Britain except:
—sections 43–45 and 52, which apply to England and Wales only
—section 53, which applies to Scotland only.

urged Ministers to reconsider, on grounds of cost, the case for full implementation of Part II. Ministers, however, reaffirmed a commitment to the full implementation of COPA II, not least because it would ease the necessary implementation in the United Kingdom of various European Community directives on environmental protection and public health, but they decided that decisions on ways of phasing in the outstanding provisions would have to depend on the availability of resources in both the public and private sectors ([107]).

4.30 Details of the outstanding provisions of COPA II are given in Appendix 4. In essence, the provisions are intended, first, to restate, in comprehensive form, water authorities' existing powers to control pollution of inland streams, rivers and estuaries; and secondly to extend their powers to control all tidal and coastal waters up to and, in some circumstances, beyond three miles from the coast, to control certain underground waters, and to control some discharges to land, land-locked lakes, lochs and ponds. In practice this means that virtually all new discharges to inland, tidal, estuarine, coastal and specified underground waters, and to land in some circumstances, will require the consent of the appropriate water authority. It also means that, with the extension of the waters under control, a number of existing discharges for which consent has hitherto not been required will require to be controlled for the first time. The Act provides for transitional arrangements to allow the new controls over existing uncontrolled discharges to be phased in and to facilitate the essentially technical process of translating consents given under existing legislation into consents under the Act.

4.31 As we have already discussed in Chapter II, COPA II introduces the important new principle of public involvement in the process of granting and enforcing discharge consents. Proposals for discharges will normally have to be advertised and, when appropriate, public inquiries held; and water authorities will be required to establish, and later make open to the public, registers containing information about applications, consents and the resultant quality of effluents and the receiving waters. Applicants will be able to appeal to the Secretary of State if they consider that publicity would prejudice trade secrets or be contrary to the public interest. If he is satisfied that this would be so, the Secretary of State will have the power to issue exemption certificates, copies of which must then be included in the registers. Water authorities' own discharges from sewage treatment works will continue to be under the control of the Secretary of State. COPA II also introduces the concept of a statutory code of good agricultural practice, to be approved by the Minister of Agriculture, Fisheries and Food. Compliance with this code will be a defence against breaches of other sections of the Act, though water authorities will have power to order changes in agricultural practice to prevent a recurrence of pollution, even when the code has been observed.

4.32 The plans that exist today for the implementation of the outstanding provisions summarised above, in Scotland as well as in England and Wales, are essentially those announced by the Parliamentary Under Secretary of State for the Environment, Mr Giles Shaw, in February 1982 (95). His statement noted that it had been necessary to strike a balance between the benefits of extending and strengthening controls over water pollution and the need to avoid increased water charges or unnecessary expenditure by water authorities and industry generally. The Government's intention, therefore, was to phase in most of the remaining provisions of COPA II over a period of four years, with the main provisions taking effect in the earlier part of the programme, to be completed by July 1984. The target date for virtual completion of the programme was July 1986, though there would need to be some 'flexibility' over phasing in case difficulties emerged during the proposed process of consultation with industry and other interested parties over the details of the extensive secondary legislation that would be needed to put the provisions of COPA II into practice.

4.33 The details of the Government's intended timetable were given in August 1982 in the first of a new series of consultation letters, issued in parallel by the Department of the Environment and the Welsh Office and, adapted as necessary to apply to Scotland, by the Scottish Development Department. The timetable is shown in the box overleaf and, so far, has suffered only a relatively minor setback. In July 1983 the Government announced that, since public consultation had taken longer than expected, Phase 1 would now be split into two stages: the Order initially exempting some discharges from control would be in force by August 1983, and the remainder of Phase 1 would be complete by November 1983; there were no changes to the announced timing for subsequent phases (108). In accordance with this plan, section 32(3)(a) of the Act was brought into operation on 10 August 1983 (SI 1983, No. 1175) and the Control of Pollution (Exemption of Certain Discharges from Control) Order 1983 took effect from 31 August 1983 (SI 1983, No. 1182). The Order requires, amongst other things, that water authorities shall give publicity to the general effect of the Order.

4.34 The general effect of the Order and, indeed, of the earlier phases of the implementation programme gives some indication of the Government's attitude to COPA II. The Order gives initial exemption to the majority of discharges which did not require consent under previous water pollution control legislation, though it does require some other discharges to come under water authorities' control, by deemed consents in the first instance and thereafter by review of these consents, at the discretion of the water authority, as improvement programmes are established. The initial phase of the implementation programme is, in practice, essentially a paper exercise necessary to effect a transition from the old to the new legislation and will have little immediate effect on pollution and none at all on old (pre-1960) discharges, which will initially be given deemed consents or be covered by exemption orders such as that mentioned above. Though the new enforcement controls will start to bite following the implementation of Phase 2 (mid-1985, assuming the announced timetable does not slip), even then progress will depend on the willingness of the Government progressively to reduce the scope of exemptions and, where necessary, to allow the water authorities adequate

Timetable announced in 1982 for implementation of Part II of the Control of Pollution Act 1974

Phase 1: to be completed by July 1983

- —exemption of classes, by type or area, of existing uncontrolled discharges*
- —translation of existing consents into COPA II consents
- —provision of deemed consents for some individual existing uncontrolled discharges
- —establishment of the procedures for applying for consent, for advertisement, for public inquiries and for appeals
- —establishment of duty of water authorities to review consents
- —provision of power for Secretary of State to exempt applications etc from publicity
- —regulation of water authorities' discharges
- —prescription of document for specifying underground waters used or likely to be used for supply
- —consideration of need for regulations on discharges containing radioactive substances

Phase 2: to be completed by July 1984

- —establishment of new offences, for both discharge without consent and breach of consent conditions
- —introduction of code of good agricultural practice
- —prescription of the particulars to be entered in consent registers, and establishment of the registers

Phase 3: to be completed by July 1985

- —opening of registers of applications, consents, effluent and water analyses etc. to the public

Phase 4: to be completed by July 1986

- —creation of powers to enable water authorities to remedy or forestall pollution

Later:—control of disposal of sanitary wastes from vessels and requirement for provision of shore facilities

The provisions to empower water authorities to levy charges for accepting sewage and trade effluent discharged into rivers under the terms of a consent are not included in the timetable.

*Regulations to implement this item came into effect in August 1983. No other items had been implemented by the end of October 1983.

resources to undertake improvement works before suitable new consent conditions can be imposed. We were somewhat concerned to learn from DOE, as we completed this Report, that the announced timetable for completing Regulations under Phase 1 might be subject to further delay.

4.35 Evidence to us from the Department of the Environment included the following statement:

> 'The plan for bringing COPA II into effect gives the Government a considerable control over the rate of implementation on the ground. While Ministers will undoubtedly take steps to bring within the controls any type of discharge (or areas of discharge) which may be defined by European Community directives as requiring to be controlled, they can be expected to have resource and economic considerations as well as environmental considerations very firmly in mind in deciding what more to bring under control, and (by variations of the exemption order) at what time.'

The approach is borne out by the Exemption Order of August 1983. Almost the only exceptions to the exemptions it makes are those necessary to implement in the United Kingdom the European Community Directives dealing with: dangerous substances discharged into the aquatic environment(13) (see paragraph 1.12), the quality of bathing water(109) (see paragraph 4.57), the quality of fresh waters(110), the quality of surface water intended for abstraction for drinking water(111), the quality of shellfish waters(112) (see paragraph 4.73), and the discharge of dangerous substances into groundwater(12) (see paragraph 1.12). While these exceptions and the implementation of these directives are certainly to be welcomed, we are concerned that further progress should not be limited to compliance with Community directives. We re-emphasise our belief in the benefits of a continuous and progressive approach to environmental improvements rather than piecemeal reaction to pressures of the moment. The Exemption Order in fact makes only one exception which is not related to European Community requirements: this is the important provision that no currently uncontrolled discharge of trade or sewage effluent into the Mersey estuary shall be eligible for exemption. This exception has been made in the light of the Government's intention to proceed with a clean-up programme for the Mersey (see paragraph 4.16) and means that the conditions under which any such discharge may continue will be governed by the terms of any consent which the North West Water Authority is willing to grant under section 34 of the Act, when this is brought into effect. Having visited the Mersey and seen the existing problems (see paragraph 4.15), we particularly welcome this exception and the potentially stronger powers it gives to the Water Authority.

4.36 Whilst we recognise that financial considerations will inevitably continue to be uppermost in Ministers' minds, we wish to stress the importance of tackling pollution problems in an order of priority which has been determined on its merit, not on grounds of expediency or merely in response to the pressure of international obligations. We must sound a warning against the use of exemption orders as a mere device for postponing action on the nastier forms of uncontrolled discharge. It is unfortunate that no safeguards have been built into the programme for implementation of COPA II to ensure that the various phases are completed by the planned dates. As we argue in Chapter VI, pollution problems are best tackled by carefully planned measures and with a firm timetable settled in advance. We therefore **recommend** that the Government should reaffirm the commitment to complete the legal implementation of Part II of the Control of Pollution Act 1974 by July 1986; furthermore, the Government and the water authorities should agree a timetable for the review of all categories of discharge initially covered by exemption orders or by deemed consents, and should agree a planned programme of improvement geared to stated water quality objectives. In this way there will be a series of clear targets against which the real effects of Part II on the quality of estuarine and coastal waters can be measured. We discuss the question of priorities in paragraphs 4.45–4.49.

Water authorities and the public

4.37 In the preceding paragraphs we have considered some of the Government's priorities for the water industry and some of our priorities for protection and improvement of parts of the aquatic environment. The issues to which individual consumers give priority will be largely determined by their own requirements and local circumstances. Thus, water authorities may find themselves having to deal with competing claims for action on matters such as the repair of collapsing sewers, the treatment of discoloured water or plumbosolvent supplies, and the security of supplies in periods of low rainfall. These claims have to be assessed alongside those for expenditure explicitly on environmental improvements that will, in general, be of less tangible benefit to any individual consumer but which can be enjoyed by the community as a whole. Domestic consumers' requirements will naturally differ from those of industry, not least because industry's demands are more directly reflected in the charges it pays for water services while charges to domestic consumers are normally based on rateable values.

4.38 In order to retain public confidence in the light of these competing and possibly conflicting claims it is important that water authorities should be as open as possible when setting the priorities in their own programmes and that they should be readily accessible to their customers and to the public in general. We have already advocated such an open approach for water authorities' handling of information about discharges to the environment (see paragraph 2.57).

4.39 When the water authorities in England and Wales were first constituted, under the Water Act 1973, the majority of their membership was nominated by the local authorities in the areas they served and only a minority was nominated by Ministers. The local authority nominees, who were almost invariably elected councillors, were then able to convey the views of their constituents to the water authority at the highest level, and there was no need for separate consumer councils of the kind that exist for most nationalised industries. However, in January 1982, in the light of three separate developments—a report by the Monopolies and Mergers Commission on the structure of the Severn Trent Water Authority(113), a decision by the Welsh Office to restructure membership of the Welsh Water Authority, and a review by the Department of Trade of consumer representation in nationalised industries(114)—the Department of the Environment put forward proposals to reorganise the boards of water authorities in England(115). The Department questioned whether the existing large boards were operating effectively, whether their uniquely hybrid structure continued to be appropriate now that the local authorities' experience in operating water services before 1974 had been assimilated by the water authorities, and whether the arrangements for making water authorities accessible to consumers were working as intended. On the last point the Department concluded that the arrangements were not working: consumers rarely knew even that they had a representative on the water authority, and members found it difficult to represent large areas satisfactorily.

4.40 The Department put forward a number of options, ranging from increased local authority membership (to improve contact with consumers) to a much reduced membership appointed solely by Ministers, with separate arrangements for consulting consumers. In responding to the Department's invitation to comment, we noted that the main emphasis of the proposals was on efficient administration and value for money in the provision of water and sewerage. Whilst accepting the importance of these primary tasks, we were also concerned that any changes in water authority membership should not result in purely commercial considerations assuming too dominant a role, to the detriment of wider aspects of environmental protection. We noted that effective contact with domestic and particularly industrial consumers would be especially important as new arrangements for the control of water pollution, under COPA II and various impending European Community directives, were brought into force. In a letter to the Department, the Commission therefore urged that the new arrangements for water authority membership should be sensitive to the needs of the environment and not inspired by too narrow a consumer-ratepayer ethic.

4.41 The present membership of water authorities, as reconstituted on 1 October 1983 under the Water Act 1983, is now much smaller (9–15 members) and is appointed solely by Ministers. None of the members is given explicit responsibility for consumers' interests, as is sometimes done on the boards of nationalised industries, but under section 7 of the 1983 Act each water authority is required to make arrangements for the representation of consumers' interests in the light of guidelines issued by the Secretary of State. After a period of consultation, these guidelines were issued in October 1983 (116) and suggest the creation of divisional consumer consultative committees and a single regional recreational and conservation committee in each water authority area. The guidelines, which are intended to provide a common framework within which water authorities will have maximum discretion to take account of local circumstances and any existing experience of consumer representation, suggest that water authorities should invite the advice of these committees on general questions such as charging principles and investment planning and that the committees should also be able to consider issues on their own initiative; each committee is recommended to publish an annual report. The guidelines make no explicit reference to questions of pollution or environmental protection and so it remains to be seen whether and how effectively the committees will be able to communicate the views of consumers to water authorities on such questions. The guidelines also do not make any explicit reference to any duty to or means by which water authorities should consult those outside their areas who, though not strictly consumers, might be affected by the consequences of a water authority's activities. Water authorities are required to submit their proposals for consumer committees to the Secretary of State by 31 January 1984 for approval.

4.42 One issue on which the water industry particularly needs to maintain public confidence, and to which consumer consultative committees might be minded to give attention, concerns water authorities' own substantial discharges from sewers and sewage treatment works. In England and Wales consent to discharge from the sewage disposal works of water authorities is given by the Secretary of State under the Rivers (Prevention of Pollution) Act 1961, though some discharges to tidal and coastal waters are not subject to control (see paragraph 4.30). When section 55 of the Control of Pollution Act is implemented (as part of Phase 1, due to be completed by November 1983—see paragraph 4.33) it is intended that these uncontrolled discharges and new discharges by water authorities will be made subject to substantially the same provisions that will apply to industrial discharges. The main difference will be that the Secretary of State, not the water authority, will be responsible for considering applications for consents and deemed consents; also, the powers of the Secretary of State to call in an application under section 35 of the Act will not apply since all applications from water authorities will already be subject to his consideration.

4.43 However, section 37 of the Control of Pollution Act (also to be implemented in Phase 1) provides for water authorities as well as the Secretary of State to initiate reviews of existing consents. It is in their exercise of this provision that water authorities must be particularly careful to consider, and be seen to consider, their own discharges no less strictly than others. Since water authorities are likely to have access to as much, if not more, information about their own discharges than is the Secretary of State, the risk of their being seen both as poacher and gamekeeper should not be overlooked. This problem is avoided on the Scottish mainland, where the prevention of water pollution is the responsibility of the river purification boards while, since 1975, water supply, sewerage and sewage disposal have been responsibilities of the Regional Councils. (Island Councils combine all these responsibilities and so will need to exercise the same care over their own discharges as will water authorities in England and Wales.)

4.44 Prior to the Water Act 1983, water authorities in England and Wales were under the same statutory obligation as local authorities to hold meetings in public. Although it appears that most water authorities are now taking advantage of the removal of this obligation, we note that the Welsh Water Authority has resolved to continue holding meetings in public on a trial basis for one year from October 1983. We feel this demonstrates encouraging continued concern for involving the public in the authority's activities, and if experience proves that it can be successfully combined with the advantages of streamlined board membership, we hope that the experiment will become permanent and that other water authorities will be inspired to follow suit. We have already emphasised in Chapter II the need for increased openness where possible. Whilst there are impeccable precedents in nationalised industry practice, it is only to be expected that, at a time when local authorities are no longer represented on water authorities and the new and less direct arrangements for consumer representation have yet to be tested, the holding of meetings behind closed doors will attract suspicion, however unjustified, in some quarters.

Priorities in the present financial climate

4.45 We have drawn attention above to the competing claims on water authorities' resources and have suggested that funds available for investment on infrastructure to improve water quality are best used in tackling the worst problems first. However, the question remains where to place the pollution of estuaries and other waters in a comprehensive hierarchy of problems. As the National Water Council told us, there is an urgent need to identify which pollution problems really matter so as to make best use of the limited resources available.

4.46 Recent limitations on resources are illustrated in Figure 4.1, which shows the historical pattern of capital expenditure on water services in real terms. Annual investment in water supply, sewerage and sewage disposal is now less than half the peak reached in 1974 (though it has been suggested to

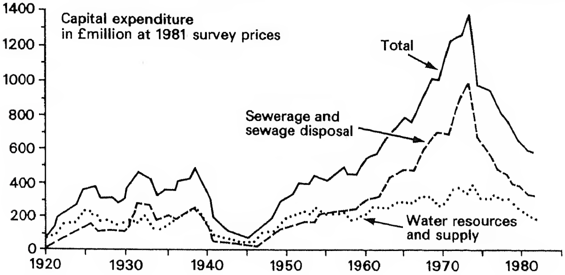

Figure 4.1
Capital expenditure on water services in England and Wales, 1920–81

Source: Reference(100)

us that this peak might have been perhaps 20 per cent lower if reorganisation of the industry had occurred earlier). While much of this fall in investment has been accommodated by reordering priorities and by economies made possible by integrated river basin management, the National Water Council concluded in 1982 that further cuts in investment were endangering existing levels of service(100).

4.47 Identifiable health hazards usually attract first priority in water authority programmes. Commitments to maintain public health standards by providing water services for new housing and industry and by dealing with sub-standard supplies, such as discoloured drinking water, have also to be met in some areas. Thereafter, water authorities have to judge the priorities to be attached to such matters as the improvement of rivers, estuaries and coastal waters and the repair of neglected sewers and leaking water mains. As the National Water Council told us, there is a tendency to share the available resources between services and across geographical areas, and priorities change only slowly unless a crisis arises. When a crisis does arise—for example, a major sewer collapse—it is inevitable that resources are diverted to deal with it at the expense of planned progress on matters that can be deferred. As the report on the water industry by the House of Lords Select Committee on Science and Technology pointed out(117), in the context of sewer repair and renewal, planned expenditure to forestall a crisis, for example by a long-term programme for relining sewers, will almost always be less expensive than dealing with it when it happens.

4.48 The implementation of COPA II will inevitably impose some extra cost on both industry and the water authorities. The additional burden cannot yet be quantified with any accuracy (though the Scottish River Purification Boards' Association estimated in 1979 that it might add just over 5 per cent on average to boards' budgets), since it will depend on the extent to which the provisions of COPA II are used to force the pace of improvements beyond that needed to meet European Community directives rather than simply to legitimise continuation of existing discharges. However, the majority of water authorities have told us that they are confident of their ability to meet the requirements of COPA II as they are phased in, though the authorities are concerned that continuing constraints on public expenditure will in effect mean that central government's financial objectives will take precedence over their water quality and other objectives. Industry also welcomes the phased introduction of COPA II, though it expects a 'sensible' interpretation of its provisions by government and water authorities to avoid unnecessary conflict and expense(69).

4.49 Given the critical role that the availability of public funds will play, and uncertainty in some other matters (for example, the criteria for reviewing consents) that have yet to be covered by the Department of the Environment's series of consultation letters (see paragraph 4.33), we find it impossible to make any estimate of the improvements to water quality that may stem from COPA II in the coming years, though we are convinced that the provisions of

COPA II do have the potential to bring about further worthwhile improvements and to sustain those that have been made in the past. The emphasis to be given to environmental improvements naturally depends on local circumstances and opinions and, again, we can give no absolute ranking. The conclusions in the House of Lords report on the water industry(117) on the false economy of planning for short-term financial objectives only, again in the context of sewer repair and renewal, have parallels in other areas of environmental protection (see paragraph 6.31 *et seq*.), and we urge the Government and water authorities to take a longer-term view when setting future water quality targets (see paragraph 4.36).

Research

4.50 The House of Lords report on the water industry(117) also included a detailed examination of the organisation and funding of research and development in the water industry. One of their conclusions, supported by evidence we have received, was that the Department of the Environment had withdrawn too far from overseeing the development of a long term strategy for research in the water industry, taking account not only of the needs of that industry but also of other industries affected by the water industry's activities. While the National Water Council existed it played a role in co-ordinating the research requirements and programmes of the water authorities in England and Wales and took a lead in strategic issues that were not of particular or immediate concern to any one water authority. The role that the new Water Authorities Association might play in the research field is not yet clear, though the Association's responsibilities will be on a smaller scale than those of the National Water Council. Thus, in the absence of the National Water Council, a number of problems may arise. First, responsibility for strategic environmental research relevant to the water industry may be unclear. The House of Lords recommended that DOE should assume this responsibility, and we endorse this view. Secondly, there is a risk of fragmentation and duplication of research effort between water authorities and the possibility that research results, particularly if they suggest failings by or a course of action unpalatable to the water authority concerned, will not be published for the benefit of other authorities. Thirdly, there is a risk that the water industry will choose to rely too heavily on its own in-house research and so not benefit from the expertise available elsewhere, for example in the Research Councils and university departments.

4.51 We believe these potential problems warrant careful consideration and, in particular, feel that DOE should take a more central role in the development of a long-term research strategy for the water industry. We are, therefore, pleased to note that the Government, whose response to the House of Lords report on the water industry was published as we completed this Report (118), intends to set up a new Research Requirements Committee within DOE, with membership drawn from the key purchasers and providers of water research and independent experts. This Committee is to report to the Secretary of State on the need for research relevant to the longer-term issues and opportunities for water authorities and other longer-term problems of water policy, including those relating to water conservation, the aquatic environment and public health. We welcome this development and hope that it will serve to forestall the problems listed above.

BATHING WATERS AND BEACHES

Introduction

4.52 We have encountered widespread concern about pollution of the coastline, particularly of beaches and bathing waters. In particular our attention has been drawn to the concern of those district councils which have a coastal tourist trade. There are issues not only of possible risks to health, mainly from micro-organisms in human sewage, but also of despoliation of the coastal landscape with consequent loss of amenity. The problems are not new—the Royal Commission considered them briefly in its Third and Fourth Reports([2, 40])—but public awareness of the issues has increased, encouraged by the activities of bodies such as the Coastal Anti-Pollution League and the Keep Britain Tidy Group.

Coastal discharges of sewage

4.53 The principal cause for concern, with regard to human health, is over the discharge to coastal waters of untreated, or partially treated, sewage (Plate 4). This can result in the presence of infectious micro-organisms in material washed up on to beaches, in bathing waters, and concentrated in some marine organisms, particularly bivalve shellfish, which are subsequently eaten by man ([119]). However, the presence of such micro-organisms does not necessarily imply a danger of disease being contracted. Domestic sewage contains a very large number of micro-organisms. Many of these are natural constituents of the human gut and normally harmless; others, including certain bacteria and viruses, may be pathogenic. These pathogenic micro-organisms can reach sewage only when they are first present in the population, and the United Kingdom population is generally free of the more severe gastro-intestinal pathogens, such as the typhoid bacillus.

4.54 It is generally considered that exposure to a large number of micro-organisms is necessary for infection. When sewage is discharged into the sea dilution is usually rapid and extensive, and most types of micro-organism are gradually killed by sunlight penetrating the water and by the salt in the sea-water. Nevertheless, unless the sewage is at least comminuted before discharge, solid particles containing large numbers of micro-organisms may appear on beaches or in bathing waters.

4.55 Until now the generally held view, as expressed to us by several government departments, has been that sewage contamination of beaches and bathing waters may create a health hazard only when conditions are so foul as to be aesthetically quite unacceptable. This view is based on the 1959 Report of a committee of the Public Health Laboratory Service(120). This committee investigated medical and bacteriological aspects of the sewage contamination of bathing beaches on the coasts of England and Wales and, in particular, undertook an epidemiological study of bathing in contaminated water and the incidence of certain serious diseases of viral (poliomyelitis) and bacterial (typhoid and paratyphoid fevers) origin. No association with bathing was found for poliomyelitis but a few cases of typhoid and paratyphoid fevers could have been due to infection during bathing in grossly contaminated waters. In more recent years there has been one case of paratyphoid fever for which there is circumstantial evidence of sea bathing as a source of infection. It should be noted, however, that the incidence of typhoid and paratyphoid fevers is now very low in the United Kingdom and all notified cases are followed up carefully. It therefore follows that the risk of the causative bacteria being present in sewage is small.

4.56 While, therefore, the risk of contracting a serious disease from bathing in the sea off the United Kingdom appears to be extremely small, we are less confident that the same can be said of milder diseases of the digestive system, such as those known as traveller's diarrhoea. There are, however, major problems in undertaking research in this field. It is extremely difficult to isolate from seawater many of the micro-organisms, particularly viruses, which cause such diseases and to obtain reliable epidemiological data on associations between bathing and minor diseases. Outside the United Kingdom claims have been made of a relationship between the incidence of mild digestive illness in swimmers and the bacterial quality of the bathing water(121). The results of another study suggested that children swimming off beaches had a greater risk of contracting viral illness of the digestive system than did children who swam only in chlorinated pools(122). Although these claims are not entirely convincing, the Department of Health and Social Security does not rule out the possibility that sewage contamination of bathing waters and beaches could be associated with an increased risk of travellers' diarrhoea and similar complaints. We believe that this is a prudent attitude to take in the light of current knowledge and that it is now necessary to modify the reliance hitherto placed on a report published almost a quarter of a century ago(120) which in any case concentrated on a few serious diseases. We note, too, that besides infecting the digestive system some faecal organisms may cause infections of the eyes (conjunctivitis) or of cuts and abrasions: children, because of their playing habits, may be particularly liable to contact with infectious material.

Bathing water Directive

4.57 In 1975 the European Community adopted a Directive (76/160/EEC)(109) aimed at improving or maintaining the quality of bathing waters to protect both human health and the environment. This Directive is concerned only with water quality and not with beaches themselves although improvement of bathing water quality is likely to result in cleaner beaches. It lists a number of physical, chemical and microbiological measurements, for most of which mandatory or guideline values are given which Member States must meet by December 1985. The most important values are for numbers of coliform bacteria which have to be counted in samples of sea water collected from bathing waters. The coliform bacteria (particularly *Escherichia coli*, usually referred to as *E.coli*), which are relatively easy to monitor, serve as indicators of the amount of sewage present but have severe limitations as indicators of the risk to health as there is no reliable relationship between their numbers and those of pathogenic micro-organisms. Some pathogenic micro-organisms, such as *Salmonella* and entero-viruses, are included but are to be counted only when they are suspected to be present. The Directive sets out a sampling regime for *E.coli* but does not specify how samples should be handled before analysis; in different conditions of temperature and sunlight monitoring results are not strictly comparable. For these reasons, together with the costs entailed in monitoring, the reliance on coliform bacteria counts has received considerable criticism([25, 123]). It is, however, much more difficult directly to monitor the pathogenic micro-organisms.

4.58 Nevertheless, several water authorities have told us that they do find monitoring for coliform bacteria a convenient and useful tool for determining the extent of contamination by sewage and for assessing priorities for capital expenditure on sewage treatment or disposal projects. Water authorities in many cases make use of the Directive's criteria as a test for waters not identified under the terms of the Directive.

4.59 Irrespective of the merits or faults of this Directive, we have encountered widespread criticism of the manner of its interpretation and implementation in the United Kingdom. The Directive defined bathing waters as all waters (including running and still freshwaters) in which bathing is explicitly authorised (not relevant to the United Kingdom), or in which bathing is not prohibited and is traditionally practised by a large number of bathers. In the United Kingdom the Government interpreted the phrase 'traditionally practised by a large number of bathers' in such a way that only 27 bathing waters—all of them coastal—were identified (see box). This figure contrasts with that of about 600 coastal beaches in England and Wales from which bathing regularly takes place([124]). Table 4.4 shows the numbers of bathing waters identified by each Member State under the terms of the Directive.

4.60 The Association of District Councils has suggested to us that the responsibility for identifying and monitoring bathing waters should be transferred to district councils. Responsibility for monitoring the bathing waters and taking necessary steps to ensure compliance with the Directive falls, in England and Wales, to the water authorities, which have been designated by the government as the 'competent authorities'. The water authorities are also responsible for disposing of sewage and there is no doubt that if a far greater number of bathing waters had been identified it would have resulted in pressures to improve or change many sewage outfalls, with a consequent financial burden. This is another example of regional water authorities in England and Wales being placed in the roles of both 'poacher' and 'gamekeeper' (see paragraph 4.43).

IDENTIFICATION OF BATHING WATERS IN THE UNITED KINGDOM UNDER THE BATHING WATER DIRECTIVE (76/160/EEC)

Member States were required under this Directive to identify as bathing waters those where bathing was "traditionally practised by a large number of bathers". No guidance was given on what was meant by "traditionally" or "large numbers". The Department of the Environment therefore devised criteria to apply in the United Kingdom. It adopted two criteria using a "commonsense assessment" rather than a "scientific or rigorous definition or analysis":

—first, that some time in the bathing season there should be at least 500 people in the water all at once (regardless of the length of the stretch of water in question);

—second, that waters where the number of bathers was assessed at more than 1,500 per mile *would* be classified as bathing waters; and that they *might* be where it was between 750 and 1,500 per mile.

It should be noted that these criteria make no mention of bathing water quality as required by the definition in the Directive.

Water authorities and district councils were asked to discuss these criteria and in particular to recommend how each water with 750–1,500 bathers per mile should be classified. The exact method of assessment was left to water authorities, but they were asked to make their count when such factors as the weather and the state of the tide were likely to attract the highest number of bathers.

Counts taken on this basis in 1979, using on the spot counting rather than more sophisticated methods such as aerial photography, resulted in 27 bathing waters being identified (Figure 4.2). Twenty three of these are in southern England; the remaining four are in Humberside and North Yorkshire. No inland waters, and no waters in Scotland, Wales and Northern Ireland were included and even such popular resorts as Blackpool (Plate 5), Brighton and Eastbourne were omitted.

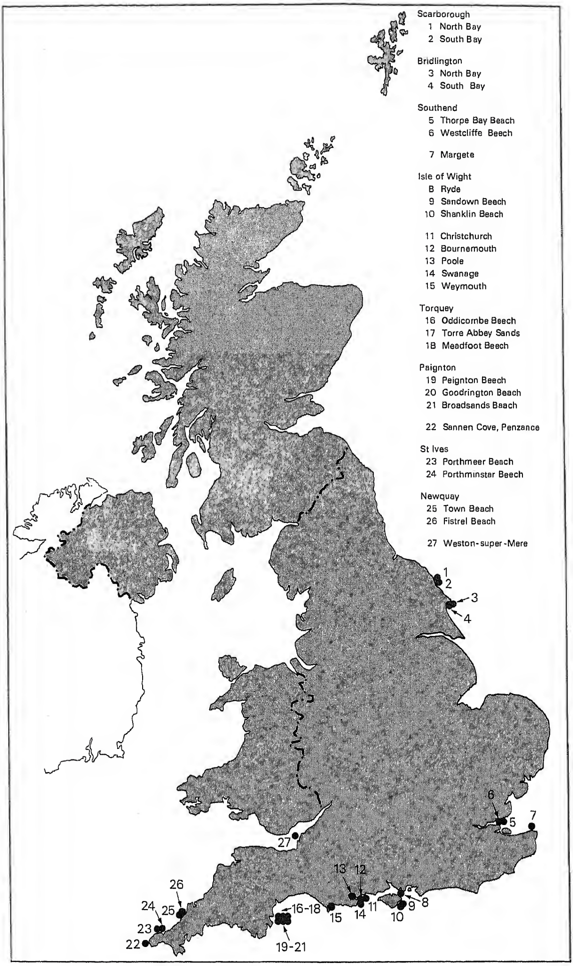

Figure 4.2
Location of bathing waters in the United Kingdom identified under Directive 76/160/EEC

Table 4.4

Numbers of bathing waters identified in each Member State in 1980 under the terms of Directive 76/160/EEC

Member State[1]	Length of coastline (km)	No. of inland bathing waters	No. of coastal bathing waters
Luxembourg	0	39	0
Belgium	66	41	15
Netherlands	850	323	60
F.R. Germany	1,050	85	9
Ireland	2,500	0	6
Denmark	3,400	139[2]	1,117[2]
France	4,140	1,362[2]	1,498[2]
Italy	5,500	57[2, 3]	3,308[2, 4]
United Kingdom	9,840	0	27

Notes:
1. Greece was not a Member State when these data were collected.
2. Number of sampling points. Not directly comparable with other data.
3. Although all the major lakes in northern Italy have identified bathing waters, the number of sampling points is specified only for L. Garda.
4. Excludes Sicily, for which the number of sampling points is not specified.

Source: Reference (125)

4.61 In discussion with officials of the Commission of the European Communities it was suggested to us that Community funds might one day become available to assist with the improvement of the condition of identified bathing waters. If these plans come to fruition the United Kingdom will find itself disadvantaged in the extent to which it can attract Community funds.

Other pollution of the coastline

4.62 Sewage is not the only source of pollution of our bathing waters and beaches. There are many others: some, such as litter and oil, are widespread and others, such as industrial discharges and mine spoil, are localised. Certain natural phenomena may at times be mistaken for pollution (see box overleaf). The issues of pollution by oil were dealt with comprehensively in the Eighth Report of the Royal Commission(6).

4.63 The problems of marine litter and its deposition on beaches have been highlighted in recent years largely due to the findings of the Marine Litter Research Programme of the Keep Britain Tidy Group. It is now appreciated that a large proportion of the litter on beaches comprises materials of low biodegradability which have been disposed of overboard from ships(126). Not only does litter present an aesthetic problem but on occasions substantial costs are incurred in cleaning operations, particularly when containers of hazardous chemicals are washed ashore. There is evidence that the international regulations for the control of dumping of garbage from ships are at present ineffective(127). In 1973 the Inter-Governmental Maritime Consultative

Organisation (IMCO)* adopted an International Convention for the Prevention of Pollution from Ships (MARPOL) which covers all forms of pollution (except authorised dumping of wastes) including disposal of garbage. Annexe V prohibits the disposal at sea of all plastic materials and of floating material within 25 nautical miles of land. However MARPOL has yet to be ratified by the United Kingdom and Annexe V is, in any case, optional. Whilst we recognise that 25 nautical miles may not be far enough, we believe that any control must be a worthwhile improvement on the present position, particularly in busy stretches of water such as the Straits of Dover (which is less than 20 nautical miles wide).

PHAEOCYSTIS

Phaeocystis, a plankton alga having brown gelatinous colonies visible to the naked eye, often forms dense blooms in inshore waters in May and June. It is sometimes deposited on beaches and produces a disagreeable smell on decaying. It is frequently mistaken by the general public for sewage. It causes the production of large amounts of foam on seawater used for cooling and may have adverse effects on fish. It is sometimes supposed that the growth of *Phaeocystis* is connected with pollution but there does not appear to be any firm evidence for this and the alga can be abundant in non-polluted waters.

4.64 The pollution of beaches and coastal waters by wastes from mining (especially coal, tin and china clay) and industry is a local problem, but when it occurs it is often a serious one. There is particular cause for concern in north east England where over 2 million tonnes of colliery waste are dumped annually on the foreshore, mostly of County Durham, together with liquid slurries from collieries further inland(128).

4.65 The foreshore and seabed, but not the beaches above the mean high water line, within the territorial waters of the United Kingdom are virtually all Crown Estate property under the management of the Crown Estate Commissioners. The National Coal Board (NCB) has to obtain approval for dumping waste colliery material at sea close to land from the Department of Transport (under section 34 of the Coast Protection Act 1949), from the Ministry of Agriculture, Fisheries and Food (under the Dumping at Sea Act 1974) and from the Commissioners. If the build-up of waste material is such that permanent reclamation of the foreshore from the sea takes place the NCB is required to purchase the reclaimed land. The Commissioners tell us that in the interests of protecting the coastline from despoliation generally it is their policy, wherever possible, to persuade the local authority to enter into a regulating lease of foreshore so that there is local supervision of its condition.

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*Now renamed the International Maritime Organisation (IMO)

4.66 In 1981 the Commission on Energy and the Environment (CENE) published its report on coal and the environment(129), which recommended that spoil should not be tipped further on beaches, that the NCB ought not to undertake marine tipping unless and until suitable methods of safeguarding habitats and amenities are found, and that the ecological consequences of pipeline deposition to the seabed should be fully examined. Even earlier, in May 1974, the Minister for Planning and Local Government, Mr John Silkin MP, had announced that the Government, the NCB and the local authorities had concluded that tipping must be brought to an end and the beaches reclaimed(130). During the course of our study we visited one of the worst affected areas (south of Dawdon Colliery, County Durham) and we were shocked by what we saw (Plate 6). Beaches in the neighbourhood were also visited subsequently by the then Parliamentary Under Secretary of State at the Department of the Environment, Mr Giles Shaw MP, who was reported in the local press as being appalled both at the scale of the problem and that such tipping was still practised. He announced that the Government, the NCB and local authorities had each agreed to contribute towards the cost of an experimental pipeline at Horden Colliery, which would take spoil some way out to sea and enable a full assessment to be made of the distance at which dispersal was adequate and the extent to which there were any adverse effects on the local marine environment. However, the Government's response to the CENE Report(131), while noting that the NCB had no plans to tip spoil on any new beaches and ideally would like to bring such tipping to an end, stated that the costs of doing so in the immediate future would be prohibitive.

Conclusions

4.67 The evidence we have received has shown that many bathing waters and beaches on the coast of the United Kingdom suffer from an undesirable degree of contamination by sewage. For example, in 1979 and 1980 several of the 27 identified bathing waters did not conform to the mandatory values for coliform bacteria (125,132); compliance with the values in the bathing water Directive, however, is not obligatory until 1985. While we accept that the risk of infection by serious disease is small, the visible presence of faecal and other offensive materials carried by the sewerage system (Plate 7) can mean a serious loss of amenity and is therefore an unacceptable form of pollution (see paragraph 1.9). It is useful to recall that a study on oil pollution and tourism in western Europe in the early 1970s(133) identified sewage as a greater cause of concern to holidaymakers than oil pollution.

4.68 In finding practical solutions there are two main issues: whether untreated sewage should be discharged to the sea, and the design and location of outfalls. The (Jeger) Working Party on Sewage Disposal ('Taken for Granted') recommended in 1970(134) that crude sewage should be discharged only after screening and comminution and through diffusers on long outfalls, the siting of which had been determined after a comprehensive study of local factors. We endorse this view. At present there are many sewage outfalls near well frequented beaches with no prior treatment of the sewage(124). The process of screening and comminution of solids not only prevents the appearance of offensive materials on beaches and in bathing waters but promotes dilution and disinfection of harmful micro-organisms. We are pleased to note that, as a result of research on the design and location of the outfalls, and with thorough site surveys, including studies of the movement of wind and water, it is becoming possible to design outfalls which reliably ensure rapid dilution of the sewage(135). With well-designed sewage outfalls we believe that discharge of sewage to the sea is not only acceptable but, in many cases, environmentally preferable to alternative methods of disposal. We therefore **recommend** that after discussion with the water industry the Government should set a date by which the recommendation of the Working Party on Sewage Disposal relating to discharges of crude sewage is to be implemented in full.

4.69 We believe that the selection criteria used by the United Kingdom for bathing waters, under Directive 76/160/EEC, were unrealistic, and we sympathise with the views of many local authorities which would welcome their bathing waters being included within the scope of the Directive. As we understand it, the terms of the Directive do not preclude a Member State from identifying additional bathing waters, though there may be problems concerning the date for notification which, in theory, has already passed. Nevertheless, we **recommend** that the Government, in consultation with the water authorities and district councils, should reconsider the selection criteria and investigate with the Commission of the European Communities the possibility of identifying additional bathing waters. Although we recognise that many such bathing waters initially would not reach the required quality standards, we consider that the action would provide a stronger and more explicit incentive for a general improvement in the quality of bathing waters and beaches around the United Kingdom. We also **recommend** that the Government should initiate negotiations with the Commission of the European Communities with a view to introducing a better sampling and analysis regime for coliform bacteria.

4.70 The problem of marine litter washed up on beaches is a particularly difficult one, as much of the litter originates in vessels outside the United Kingdom's territorial waters. Nevertheless there are actions which can be taken to mitigate the problem. On the international front we **recommend** that the Government should ratify the MARPOL Convention and draw the attention of shipowners to the provisions of Annexe V. While we have not been able to study in detail the particular problem of the inshore dumping of litter, we **recommend** that the Government, in association with the Keep Britain Tidy Group and the local authority organisations, should give high priority to improving public education on the problem of marine litter and to encouraging appropriate authorities, for example at marinas and on ferries, to provide adequate means for the disposal of shipboard litter.

4.71 We are disappointed by the response of the Government to that part of the report of the Commission on Energy and the Environment dealing with the tipping of colliery spoil on beaches. We regard the state of the affected part of the County Durham coastline as quite unacceptable and we **recommend** that an early date, at least within five years, should now be set by which all tipping of colliery waste on the foreshore of the United Kingdom must come to an end, and that plans should be put in hand for remedial action on the affected beaches. Such remedial action should not entail any extension of existing offshore dumping operations.

SHELLFISH WATERS

4.72 There are several parallels between the European Community bathing water Directive (paragraphs 4.57–4.61) and the Directive on shellfish waters (79/923/EEC)([112]). Both set quality criteria for coastal waters; both have been the subject of scientific criticism; and there has been dissatisfaction of the manner in which both have been interpreted and implemented in the United Kingdom.

4.73 Under the shellfish waters Directive Member States designate coastal and estuarine waters which are to be protected or improved in water quality for the support of bivalve and gastropod molluscs, such as cockles, mussels, winkles, oysters and clams. Within six years of designation the waters must conform to values set for a number of physical, chemical or bacteriological measurements. The Directive specifies some mandatory and some guideline values and also specifies monitoring frequencies.

4.74 There has been some confusion over whether the Directive is designed solely as an environmental quality measure to encourage shellfish growth, or whether it is concerned with protecting human health by reducing contamination of shellfish consumed([25]). The wording of the Directive implies that, while it is primarily concerned with environmental quality, Member States may use the Directive as a means of protecting human health. It appears that in the United Kingdom the Directive is interpreted by the Government as having no element of public health protection.

4.75 The United Kingdom has designated 29 shellfish waters (Figure 4.3) and all of these appear to be waters which already meet the water quality standards or will do so within six years of the designation date following improvements already planned. Thus implementation of the Directive has had no effect on the quality of shellfish waters in the United Kingdom. However the Directive has provision for further designations of waters to be made, and in the United Kingdom these may be made when Part II of the Control of Pollution Act 1974 is brought into force, extending the area of coastal waters for which discharges are controlled.

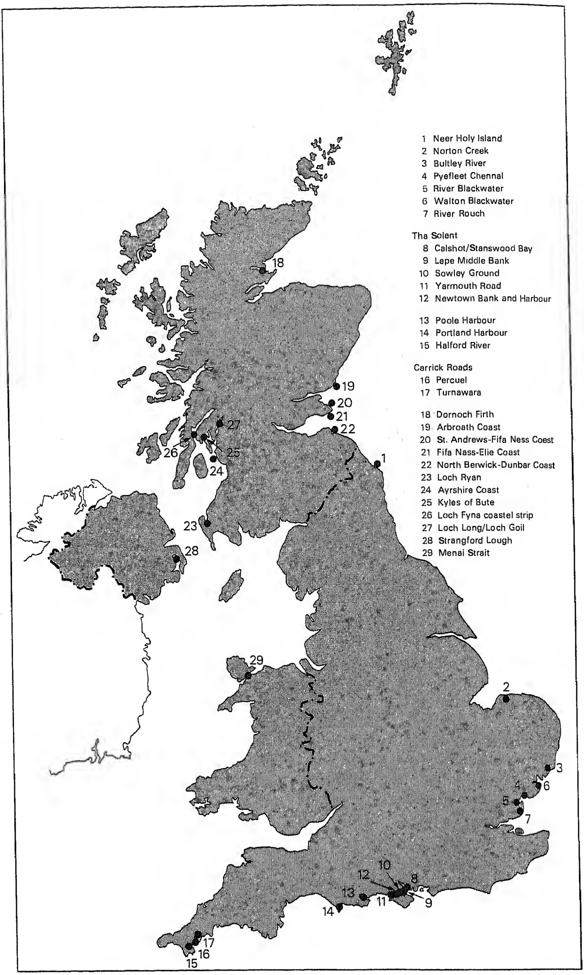


Figure 4.3
Location of shellfish waters in the United Kingdom designated under Directive 79/923/EEC

4.76 It has been put to us by representatives of the shellfish industry that this is a most unsatisfactory position for commercial as well as environmental and health reasons. The possibility cannot be ruled out that other Member States, placing greater emphasis on a public health interpretation of the Directive, might attempt to accept imports only from designated waters. There is already a memorandum of understanding between the governments of the United Kingdom and the United States of America concerning the importation of shellfish into the United States, where they have to meet stringent sanitation requirements.

4.77 Despite this Directive's somewhat ambiguous nature, we see no advantage in the negative approach to its implementation which has been adopted in the United Kingdom, although we note that some other Member States have designated no waters. We **recommend** that the responsible authorities (the Water Authorities in England and Wales, and the Scottish Development Department) should make positive use of the enhanced powers in Part II of the Control of Pollution Act 1974 for the purposes of designating further waters under the shellfish water Directive and to achieve a programme of continually expanding improvement, to the benefit of both the environment and human health, and in the interests of successful commercial shellfish farming.

THE NORTH SEA

4.78 Concern about the possible accumulation and effects of contaminants of the seas around our shores, particularly the North Sea, was expressed in both the Commission's First and Third Reports([1,40]). Most attention has been paid to potential pollution problems of the North Sea. This is understandable bearing in mind the number of surrounding industrial nations, and the number of major rivers with heavy contaminant loads which drain into it. We note however that water quality and pollution problems of the Irish Sea have not received such close attention in international circles.

4.79 The problems of the North Sea illustrate both the concept of best practicable environmental option (BPEO), which was developed in the Commission's Fifth Report([3]), and the growing importance of the international dimension in pollution control. The North Sea is an area into which the wastes of many nations pass through a variety of pathways. In recent years there have been well publicised claims, both in the United Kingdom and in other countries bordering the North Sea, that the water quality is being seriously affected by a wide variety of pollutant inputs([136,137]) including dumping from ships, discharge from rivers and direct discharge from the land. The Council of the European Communities has announced its intention to extend measures aimed at the protection of the North Sea, with priority to be given to co-ordination of administrative and legal policy([19]). The Federal German Government has proposed to other Member States that an international conference on the protection of the North Sea is convened to be followed by a harmonised campaign.

4.80 In the Commission's First Report, published in 1971(1), the need to control the dumping of noxious materials at sea was identified as a high priority for action. As part of the growing international interest in environmental matters, sea dumping was recognised as a field where international agreement on controls was both desirable and practicable. Two international conventions controlling dumping in the North Sea, generally known as the Oslo(138) and London(139) Conventions, came into operation in the mid-1970s and within the United Kingdom the Dumping at Sea Act 1974 replaced by statutory controls a voluntary notification scheme for industrial wastes and sewage sludge disposal at sea(140). It is an offence to dump any material in the sea from a ship or other vessel without a licence from the relevant authority. While the London Convention is a global measure, the Oslo Convention applies only to the North Sea and North East Atlantic. Both conventions have been ratified by all North Sea coastal states with the exception of Belgium, which has ratified only the Oslo Convention.

4.81 While the provisions of the two conventions are broadly similar and the precise nature of their relationship has not been defined, it appears to be the intention that the more regional agreement (the Oslo Convention) should apply more detailed and, if necessary, more stringent controls. The Oslo Convention, which is supervised by an intergovernmental body known as the Oslo Commission, regulates both dumping and incineration of wastes at sea, draws up codes of practice for particular substances and activities and collects data for different types of waste. This Convention was among the first to categorise substances according to their potential for damage to the marine environment: substances on the 'black list', because of their toxicity, persistence and bio-accumulation, may not be dumped, while substances on the 'grey list' which exhibit similar but less marked characteristics may only be dumped when special care is taken (see paragraph 1.12). Examples from the 'black list' are cadmium, mercury and carcinogenic substances; the 'grey list' includes lead, cyanides and fluorides. Wastes not on either list nevertheless require a specific or general permit from the national authorities before they can be dumped at sea.

4.82 The Paris Convention of 1974(141) came into force in May 1978 following the ratification by the United Kingdom in April of that year. It is aimed to control land-based discharges (both direct and indirect) to the North East Atlantic and dependent seas, excluding the Baltic and the Mediterranean. The European Community and thirteen individual states are party to this Convention, though several have yet to ratify it. The Paris Convention is designed to be complementary to the Oslo Convention and there is a joint monitoring programme covering sites affected both by discharges and by dumping. The Paris Convention also has 'black' and 'grey' lists. Contracting parties undertake to eliminate, as a matter of urgency, pollution by 'black list' discharges and to reduce or, as appropriate, eliminate pollution from 'grey list' discharges. The Paris Commission, the supervisory body, has so far concentrated its activities on measures to eliminate pollution by mercury, hydrocarbons and polychlorinated biphenyls (PCBs) and is now considering cadmium.

4.83 The Bonn Agreement(142) was signed in 1969 by the eight countries bordering the North Sea and thus has a more restricted geographical coverage than the Oslo and Paris Conventions. It originally dealt with pollution by oil but in September 1983 it was extended to include other harmful substances. It is concerned with communication and mutual assistance between contracting parties in the event of incidents involving oil pollution. This agreement was discussed in the Royal Commission's Eighth Report(6).

4.84 To complete the picture of conventions and agreements affecting the North Sea, mention should be made of both the MARPOL Convention and ICES. The MARPOL Convention (see paragraph 4.63), is in the process of being ratified and is applicable world-wide. The section dealing with the prevention of oil pollution from ships entered into force in October 1983. That dealing with the control of pollution from chemical cargoes will enter into force in 1986. Other sections have yet to receive the necessary number of ratifications. The International Council for the Exploration of the Sea (ICES) is an intergovernmental scientific body with a wider membership than the Oslo and Paris Commissions. It has been actively engaged in co-ordinating the national programmes for monitoring the North East Atlantic.

4.85 The North Sea has no generally accepted geographical delineation. Here we consider it to include the Skagerrak and Kattegat but not the Baltic Sea, the English Channel or the Irish Sea. To the north it is bound by an imaginary line stretching from the Shetland Islands to Bergen. This area of water is largely landlocked, except to the north, and is mostly shallow: the depth of the southern and south-eastern parts is generally less than 50 metres. However it does not follow that it is a largely stagnant body of water with little exchange with adjoining seas. In this respect the North Sea cannot be compared with the Mediterranean, where exchange of water with the Atlantic Ocean is very slow(143) or even with the Irish Sea(144).

4.86 A recent study by the International Council for the Exploration of the Sea(145) has shown some of the main large-scale features of North Sea circulation, which is both complicated and incompletely understood. There is a highly variable response of the sea to spasmodic wind patterns, superimposed on slower drifts driven by variable density gradients in the North Atlantic Ocean and residual flows set up by the tidal currents (Figure 4.4). The main outflow is northwards through the deep part of the Norwegian Trench close to the Norwegian coast. This is balanced by net inflows northwards through the Dover Strait, westwards through the Skagerrak and southwards in the region of the Orkney and Shetland Islands. These net flows only give a simplified picture however. In the Skagerrak, for example, although there are large flows of water in each direction the net flow, which is westwards, is rather weak.

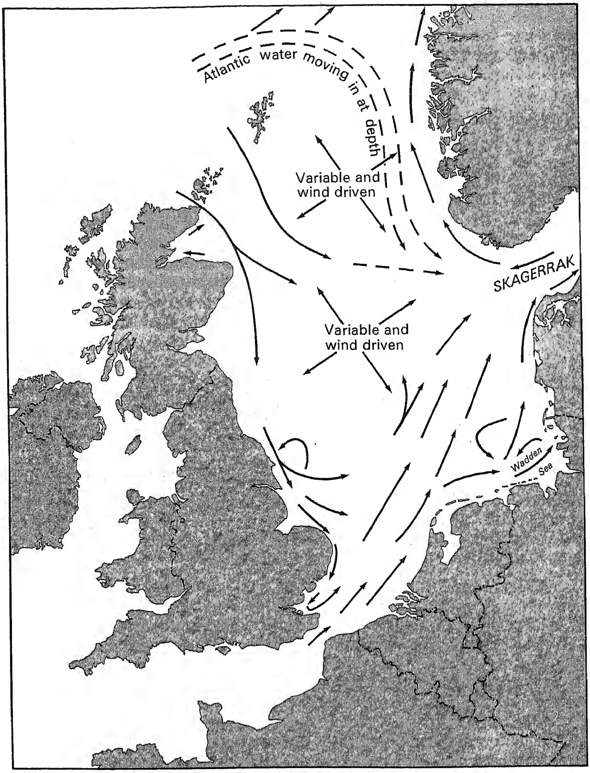


Figure 4.4
General near-surface pattern of water movements in the North Sea

Source: Reference([146])

4.87 A computer modelling study based on observed data has calculated depth-averaged flushing times for seven sub-areas of the North Sea, ranging from 46 to 333 days(147). The study showed that flushing time has a strong seasonal dependency, with smaller values in the winter, reflecting the seasonal variations in the magnitude of the wind stress. Flushing times of the order of days (rather than months) were obtained for a surface layer of depth 10 metres, showing that the magnitude of the wind stress on a daily rather than a seasonal basis determines how long it takes a pollutant in the surface layer to leave a particular area(147).

4.88 Direct information on the actual movement of contaminants has been obtained by using the presence of a radioactive isotope of caesium (^{137}Cs) as a tracer. Before 1970 the background concentrations in the North Sea originated almost entirely from fallout following the atmospheric testing of nuclear weapons. However, with the reprocessing of irradiated nuclear fuel at Windscale (Sellafield) in the United Kingdom and Cap de la Hague in France, elevated concentrations of ^{137}Cs were detected in the southern North Sea in 1970 and in the north-western part in 1971. There is, however, no indication that the concentrations currently reached constitute a hazard to man or marine life. The concentration patterns have since been charted (Figure 4.5).

4.89 Contaminants enter the North Sea by direct discharge to coastal waters and estuaries, from rivers, from dumping from ships and by atmospheric deposition. Minor pathways include incineration at sea and leakage from oil well installations. Although it is impossible to produce very accurate figures there have been several recent attempts to construct an inventory of contaminant inputs, of which the most comprehensive is from the Water Research Centre(148, 149). This suggests that rivers and atmospheric deposition are the main input pathways for the metals (Table 4.5; Figures 4.6–4.8) with the Rivers Elbe, Rhine and Meuse contributing over half the

Table 4.5

Estimated contaminant loads to the North Sea (tonnes/year)

Source	*BOD*	*N*	*P*	*Cu*	*Zn*	*Pb*	*Cr*	*Cd*	*Ni*	*Hg*
Atmosphere	—	—	—	3,450	10,750	4,500	720	530	1,650	6
Rivers	640,000	840,000	90,000	1,950	13,840	2,430	1,820	280	1,620	30
Direct discharges	440,000	120,000	30,000	310	5,570	560	210	20	310	6
Dumping of sewage sludge	60,000	10,000	3,000	120	390	110	60	10	60	3
Dumping of other wastes	—	—	—	190	520	240	20	<0.4	100	<0.4
Total	1,140,000	970,000	123,000	6,020	31,070	7,840	2,830	840	3,740	45

—indicates lack of data

BOD biochemical oxygen demand
N nitrogen
P phosphorous

Cu copper
Zn zinc
Pb lead
Cr chromium

Cd cadmium
Ni nickel
Hg mercury

Source: References(88, 148)

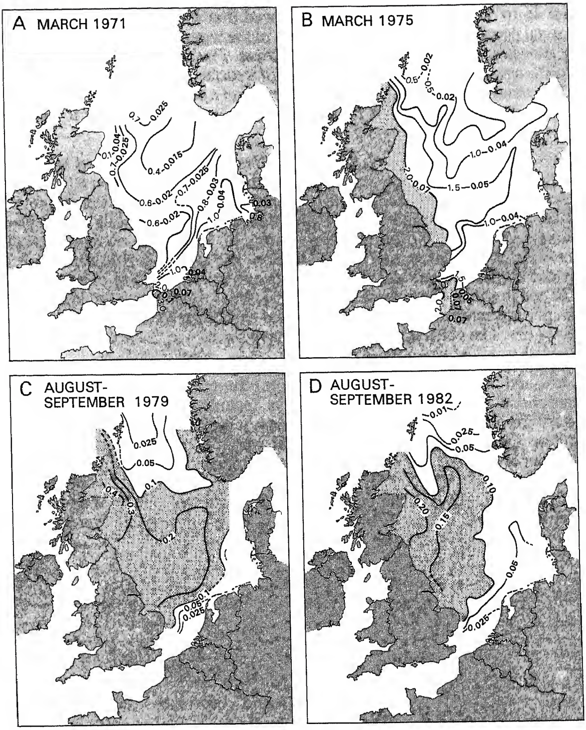


Figure 4.5
Changes in the activity of caesium–137 in the North Sea, 1971–1982

The activity is expressed in becquerels per kilogram of seawater (bold figures). A becquerel corresponds to the radioactivity decay of one atom per second. In A and B only the activity is also expressed in the old units of picocuries per litre.

Source: References(88, 146)

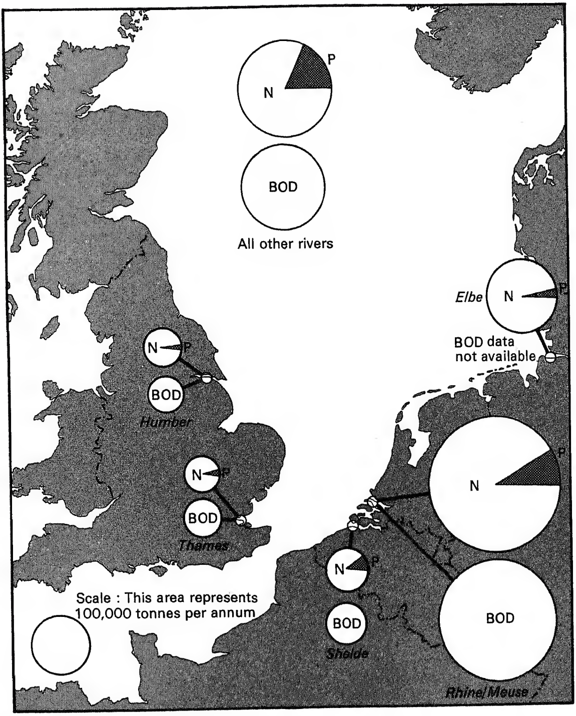


Figure 4.6
Estimated contaminant loads to the North Sea from major rivers: nutrients

Source: Reference(148)

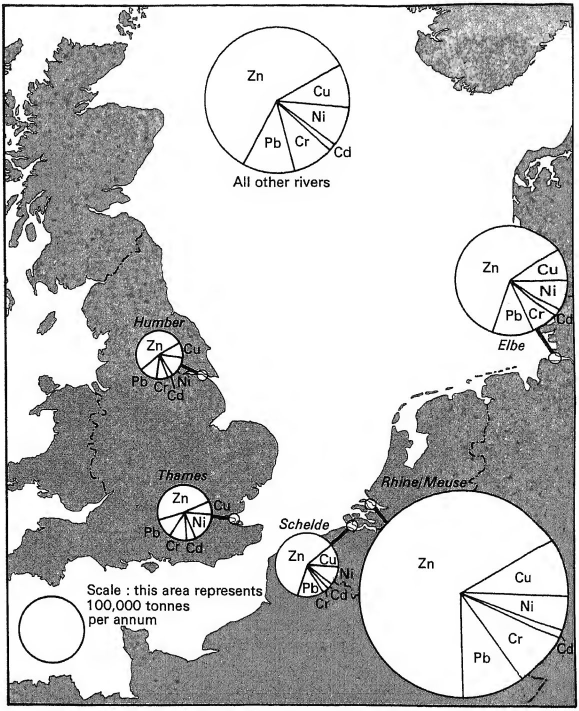
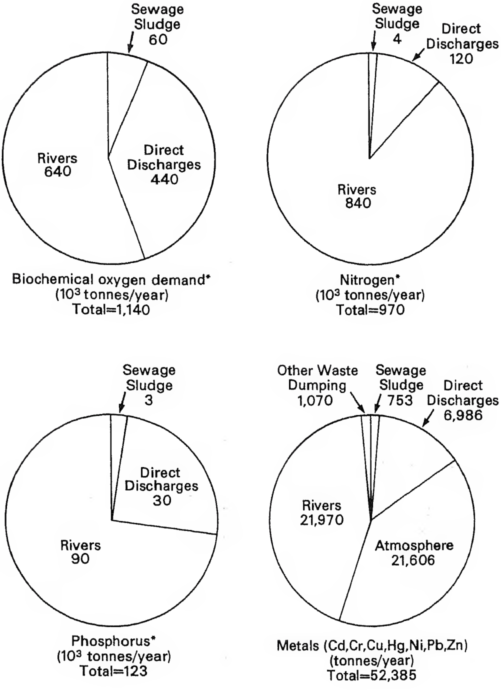


Figure 4.7
Estimated contaminant loads to the North Sea from major rivers: metals

Source: Reference(148)



*data not available from atmosphere or from dumping of other wastes

Figure 4.8
Estimated contaminant loads to the North Sea by different pathways

Source: Reference(148)

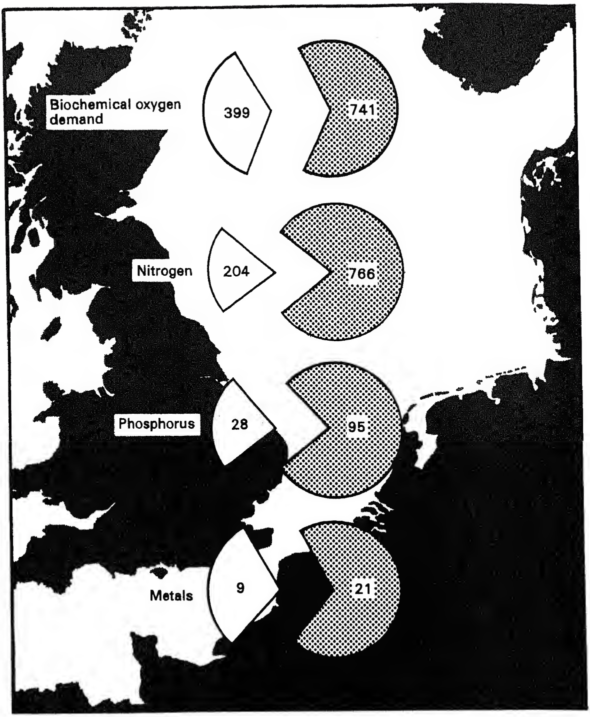


Figure 4.9
Estimated contaminant loads to the North Sea from the western and eastern coastlines
Input from the western coastline (England, Scotland) shown in open sectors; input from the eastern coastline (Belgium, Netherlands, Federal Republic of Germany, Denmark, Sweden, Norway) shown in stippled sectors. Figures in thousand tonnes.

Source: Reference(148)

total riverine input (Figures 4.6 and 4.7). For copper, lead and cadmium atmospheric deposition is the major pathway to the North Sea (Table 4.5). The dumping of estuarine dredging spoils results in a input of metals which appears to be greater than can be accounted for solely by redistribution of riverine material(149). Rivers are the main pathways of nutrients (nitrogen and phosphorus), though direct discharges also make an appreciable contribution. In addition to those bordering the North Sea, several other countries contribute contaminants through discharge to rivers such as the Rhine and Elbe and by emissions to the atmosphere. Figure 4.9 shows the inputs from all routes (other than by atmospheric deposition) reaching the North Sea from the western and eastern countries.

4.90 It is not a simple matter to evaluate the effects of these contaminants on the biota of the North Sea. It is perhaps most helpful to look at studies of individual contaminants and then at different areas and habitats within the region. In most cases contaminants can be detected only by their elevated concentrations in water, sediments or biota. It is usually difficult to identify biological effects except in cases of gross contamination as such effects may be indistinguishable from those due to natural factors or to other activities of man (such as over-exploitation of fisheries).

4.91 The effects of oil pollution on the marine environment in general were considered in the Eighth Report of the Commission(6). It was concluded that, while the short-term consequences of oil pollution are serious, the marine environment appears to have a remarkable capacity for recovering from the effects of even the largest oil spillages, and it found no grounds for concern that oil may constitute a chronic threat to the marine ecosystem or, indirectly, a threat to man. We stand by these conclusions today in the specific context of the North Sea with its major marine oil fields.

4.92 Sewage sludge, industrial waste and dredge spoils are all dumped in the North Sea under licence. The most important constituents of sludges and other wastes, when disposal is considered, are nutrients (nitrogen and phosphorus), metals and persistent organic compounds mainly from industrial effluents and urban runoff, and pathogens from excreta and food processing. The Ministry of Agriculture, Fisheries and Food (MAFF) spent £0.43m in 1982/83 on monitoring dumping grounds around the coasts of England and Wales, on associated services (for example, toxicology) and on enforcement and other activities related to the Dumping at Sea Act 1974. The general objectives of the monitoring are to establish the dispersal of the waste and its effects on the physical and biological characteristics of the dumping grounds. The effects of sludges and wastes depend in general on the rate of dispersion and the amount of material dumped. In all the dumping areas which have been studied in detail it has been possible to identify some enrichment of the sediment by organic matter and metals. In the dumping area off the River Humber, for example, where there is rapid dispersion, the elevations are slight and localised(150). For an example of where dispersion is minimal and elevations are great it is necessary to look beyond the North Sea. The most extreme example is the small and well-defined area of sea bed off Garroch

Head in the Firth of Clyde where large quantities of sewage sludge and industrial waste from Glasgow have been dumped for many years(151).

4.93 At all these sites changes in the marine life can be detected on the sea floor in the immediate vicinity of the dumping grounds, but these changes are generally considered to be of minor ecological importance and of no significance with regard to the productivity of fisheries in the area. Monitoring of fish and shellfish has shown elevated concentration of 'black list' metals and organochlorine compounds (see paragraphs 1.12 and 4.81) in samples taken from the vicinity of the larger dumping areas, such as the Thames estuary, but concentrations appear to have been decreasing over the last decade(151).

4.94 The limited studies of areas used for dumping of colliery waste and dredge spoils have shown major effects on the sea floor fauna, and physical obstructions at the sea floor have restricted trawling and potting. At least 40 km^2 of the sea bed off north east England are affected in this way(128). Considerable attention has been given, particularly in the Federal Republic of Germany, to reports that fish disease is associated with dumping of a variety of wastes, in particular tumours (epidermal papillomas) of bottom-feeding flatfish with waste acids from the manufacture of titanium dioxide(152). The evidence, though circumstantial, has been influential in curtailing the dumping activities of the Federal Republic. No comparable association between dumping activities and fish diseases have been found in the major dumping grounds off the United Kingdom(88).

4.95 It is important to ensure that the effects of dumping are contained and therefore that sewage and other wastes are dumped only at the correct locations. This is particularly so at sites such as Garroch Head (see paragraph 4.92) which are effectively 'sacrificial sites' for this purpose. MAFF, in its evidence to us, has admitted that in certain areas there is a problem of policing dumping, notably in ensuring that licensed operators do not cut costs by releasing the waste materials nearer to the home port(128). MAFF has told us that it is investigating the possibility of using aerial surveillance, and tachograph-type devices in licensed vessels, to reduce this problem.

4.96 The effects of contaminants reaching the North Sea by rivers are most pronounced in estuaries. The consequences of pollution of estuaries both in the United Kingdom and other countries bordering the North Sea are dramatic and undisputed. Over the last century the variety of marine life, and in particular the level of fish catches, in the major industrial estuaries has declined due substantially to pollution. However, there have been recent improvements in many estuaries (see paragraph 4.10); the most notable example is the Thames estuary, which provides clear evidence of the improvements which can be achieved(153)—the first salmon since 1835 was caught in August 1983.

4.97 There is evidence that pollution is having an adverse effect on the marine life of some estuarine and coastal waters of the North Sea. An area outside the United Kingdom for which particular concern has been expressed is the Wadden Sea, an area of shallow water in the southern North Sea between Den Helder in the Netherlands and Esbjerg in Denmark(136). Convincing evidence for effects away from the coasts is hard to find although there is some bioaccumulation of metals and organochlorine residues in the marine food chain. Concern has also been expressed that in the longer term effects on the estuarine and coastal waters will inevitably be reflected in the whole ecosystem of the North Sea ([136]) because of the key role which these areas play in biological productivity.

4.98 The admittedly incomplete knowledge of the movements and residence times of water in the North Sea does not support the view that the area acts as a trap for all contaminants dumped or discharged in its waters. We cannot accept, on the basis of available information, that there is at present a substantial threat to the North Sea([136, 137]). However, there is environmental damage to some estuarine and coastal areas and the effects of bioaccumulation of some metals and organic compounds on populations of marine species, including those of commercial importance, are a matter of uncertainty. There is a need for further research on this issue.

4.99 Nevertheless, we believe that the future health of the North Sea cannot be assured if the present pressures increase. Without the present international agreements, such as those which control dumping and discharges, the North Sea could be vulnerable to extensive and perhaps irreversible damage. The pressures are not only from pollution but also from overfishing, and reclamation of ecologically important coastal areas([136]).

4.100 Different bordering countries have different perceptions of the magnitude of the risk of damage to the North Sea and of the actions which are desirable to minimise the risk. For example, the United Kingdom, with its long coastline and strong tides, sees both environmental and economic advantages in making use of the capacity of the seas to take waste materials. Other countries, with shorter and more vulnerable coasts, take a more pessimistic view of possible damage. For example, the Federal German Republic's *Vorsorgeprinzip* (anticipation principle) emphasises prudence and preventative action and is heavily weighted towards elimination of all 'black list' substances, on the grounds that present levels of dilution are not relevant to the long-term hazard posed by this group of persistent and bioaccumulating pollutants.

4.101 The North Sea provides a good example of the international dimension of many of the current pollution issues. There has been a considerable amount of research on the inputs and effects of contaminants and we believe that a comprehensive review of the data is needed. It would be appropriate for this to be conducted under international auspices. We therefore **recommend** that the Government should respond positively to the initiatives of the Federal German Government and the Commission of the European Communities concerning the North Sea, and should promote international sponsorship of a review by an independent group of experts. The objective of such a review would be to consider whether current international controls are adequate to protect the environment of the North Sea. In addition we **recommend** that further studies should be undertaken on the inputs and effects of contaminants to the Irish Sea.

CHAPTER V

AIR QUALITY

That inverted Bowl they call the Sky

Edward FitzGerald, *Rubáiyát of Omar Khayyám*

Introduction

5.1 In this chapter we present a review of what we perceive to be the major problems over the next two decades or so in the field of atmospheric pollution. After considering changes in air quality and in monitoring since publication of the Commission's Fourth Report in 1974(2), we go on to consider a number of specific issues under the following headings: indoor air quality; motor vehicle exhausts; photochemical oxidants; acid deposition; stratospheric ozone depletion; and carbon dioxide and climatic change. Finally we make some general comments about energy production strategies, a subject which will be of great importance for future air quality. We have not been able to carry out detailed studies of all these areas, but we have attempted to outline the problems and identify the key issues, and we are ready to return to any of them when appropriate.

5.2 The choice of these headings in itself serves to illustrate the marked change which has occurred over the last few decades in the nature of the most pressing air pollution problems. Some 25 years ago the most serious problem was the air quality of urban and industrial areas and its overt effects on health. Since then there have been dramatic improvements in air quality, with reductions in ground level concentrations of smoke (Figure 5.1) and sulphur dioxide (SO_2) (Figure 5.2) and corresponding gains for health, visibility and amenity. These improvements were recorded in the Commission's Fourth Report(2) and have continued. A number of factors have been responsible: legislation (in particular the Clean Air Acts of 1956 and 1964, and the Alkali Works Orders 1958 and 1966), changes in both domestic and industrial fuel usage, technological advances, dispersion from taller chimneys, energy conservation and, unfortunately, industrial recession.

5.3 Despite these real improvements there are still problems locally and several localities in the United Kingdom do not yet comply with the limit values for smoke and SO_2 set by the European Community Directive 80/779/EEC(155) (see box on page 113). We have been made aware by local authorities and other bodies of the difficulties in ensuring that only approved fuels are used in areas covered by smoke control orders under the Clean Air Acts. We believe, however, that the magnitude of the problem is not great enough to warrant further legislation. There are also potential problems for the future. Many of the industrial plants that have closed during recent recession used older technologies and were responsible for considerable pollution.

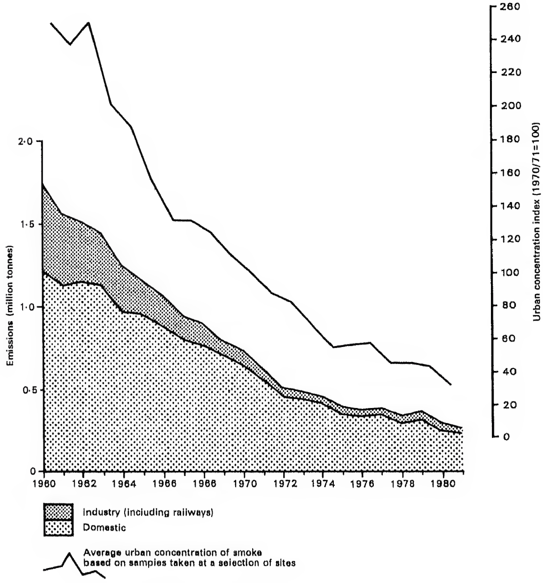


Figure 5.1
Smoke emissions from coal combustion and average urban concentrations in the United Kingdom, 1960–1981
Source: Reference (154)

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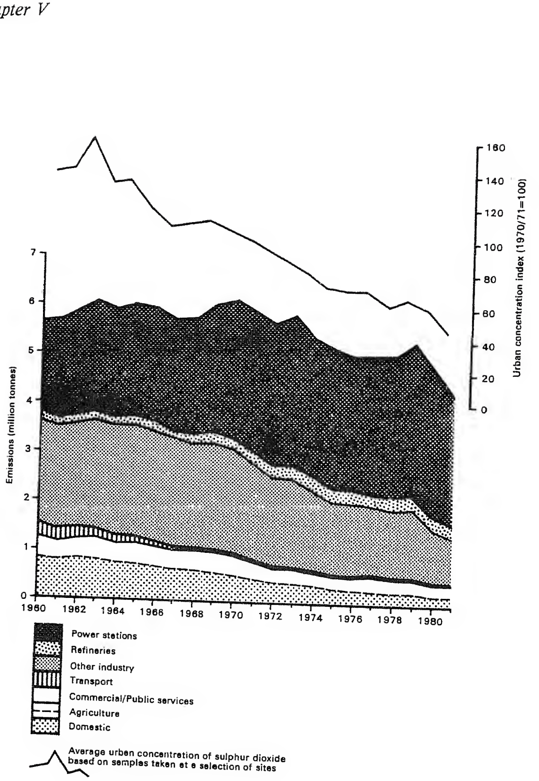

Figure 5.2
Sulphur dioxide emissions from fuel combustion and average urban concentrations in the United Kingdom, 1960–1981
Source: Reference (154)

SMOKE AND SULPHUR DIOXIDE CONCENTRATIONS IN AIR

European Community Directive 80/779/EEC was the first directive to set mandatory air quality standards. These relate to smoke and sulphur dioxide (SO_2) and are intended to protect human health and the environment. Methods for measurement are prescribed.

The limit values for the ground level concentration of smoke (suspended particulates) are as follows:

Yearly	Median of daily values throughout the year	80 $\mu g/m^3$ (68 $\mu g/m^3$)
Winter	Median of daily values from 1 October to 31 March	130 $\mu g/m^3$ (111 $\mu g/m^3$)
Peak	98 percentile of daily values throughout the year	250 $\mu g/m^3$ (213 $\mu g/m^3$)

Due to differences in measurement techniques the values for smoke specified in the Directive are not directly comparable with those from the UK National Survey (see paragraph 5.10 and Figure 5.1). The figures in brackets in the tables above and below are the equivalent values for comparison with National Survey data.The limit values for the ground level concentration of SO_2 are more complicated as they depend on the actual smoke concentration:

Yearly	Smoke concentration $\leqslant$ 40$\mu g/m^3$ (34 $\mu g/m^3$)	120 $\mu g/m^3$
	Smoke concentration > 40 $\mu g/m^3$ (34 $\mu g/m^3$)	80 $\mu g/m^3$
Winter	Smoke concentration $\leqslant$ 60 $\mu g/m^3$ (51 $\mu g/m^3$)	180 $\mu g/m^3$
	Smoke concentration > 60 $\mu g/m^3$ (51 $\mu g/m^3$)	130 $\mu g/m^3$
Peak	Smoke concentration $\leqslant$ 150 $\mu g/m^3$ (128 $\mu g/m^3$)	350 $\mu g/m^3$
	Smoke concentration > 150 $\mu g/m^3$ (128 $\mu g/m^3$)	250 $\mu g/m^3$

The limit values were to be met by 1 April 1983 but for localities where they were unlikely to be achieved the Commission of the European Communities was to be informed of plans for improvement to ensure compliance by 1 April 1993. In February 1983 the Department of the Environment notified the Commission of 21 district councils in England (one additional district council has subsequently been included), four in Scotland and three in Northern Ireland with localities which would not comply by 1 April 1983. The notification also stated the Government's intention to ensure, if necessary by use of powers in the Clean Air Acts, that the local authorities for the districts concerned introduced additional smoke control programmes.

New industrial plants are, in general, likely to produce atmospheric emissions on a smaller scale, although new technologies may produce new pollution problems (see paragraph 6.13). Nevertheless, it is probable that renewed industrial activity will lead to an increase in emissions, and resulting ground level concentrations, of gaseous contaminants. In particular, increases in the industrial and domestic uses of coal and its conversion to substitute natural gas are potential causes of future increases in air pollution(156).

5.4 Data on the emissions and concentrations of other atmospheric contaminants are less systematic and reliable than those for smoke and SO_2. The data on lead were considered in our Ninth Report(7). Figure 5.3 shows the estimated emissions of nitrogen oxides (NO_x)*, carbon monoxide (CO) and hydrocarbons. It should be stressed that these estimates for NO_x, CO and hydrocarbons are based on very uncertain data and both the absolute emissions and trends may need revision in the light of experimental work currently in progress. The main source of CO emissions is petrol-engined motor vehicles. Although emissions from motor vehicles also contain considerable amounts of NO_x and hydrocarbons, power stations using fossil fuels are the largest source of NO_x while leakage of natural gas and industrial emissions (including solvent evaporation) are the main sources of hydrocarbons.

5.5 There are some atmospheric contaminants, now considered to be important, for which there are few data. This applies in particular to ozone and other photochemical oxidants (see paragraph 5.73) which are formed in the atmosphere rather than emitted directly. Reliable data on rainfall acidity are also scarce (see paragraph 5.81). In these cases the conclusions which can be drawn from trends are greatly limited. Data on the emissions of atmospheric contaminants in the United Kingdom can thus be considered to fall into three categories. There are good data for smoke (Figure 5.1) and SO_2 (Figure 5.2), while data for NO_x, CO and hydrocarbons are available but, unfortunately, of low reliability. Data for most other contaminants are largely lacking. We must express our regret that we were unable to obtain any official figures for emissions in 1982.

5.6 Over the last quarter of a century perceptions of the principal atmospheric pollution problems have changed, partly as a result of the successes in reducing smoke and SO_2 concentrations, and partly through greater, though still far from complete, knowledge of the occurrence and effects, or possible effects, of other contaminants, including those present in trace amounts. Many of the issues no longer concern immediate damage to human health but involve long-term effects on components of the biosphere or the atmosphere. Many are no longer simply local, but are on a regional or global scale.

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*The shorthand NO_x refers to unspecified oxides of nitrogen, usually a mixture of nitric oxide (NO) and nitrogen dioxide (NO_2).

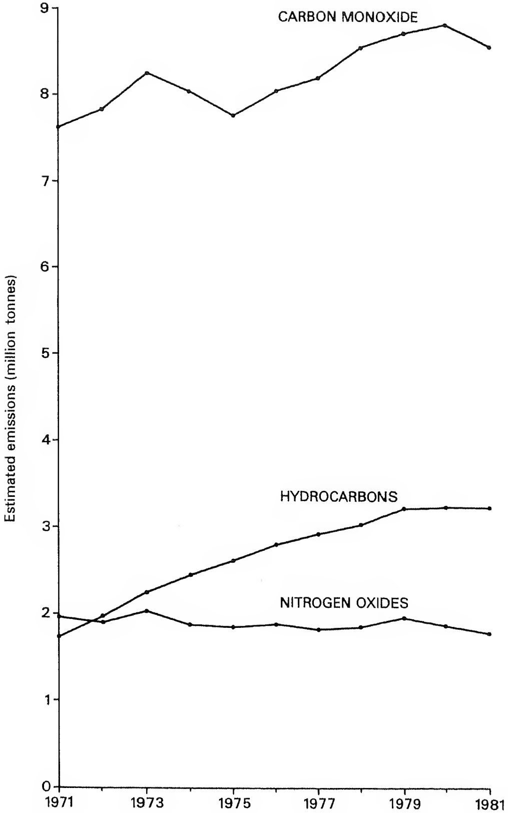

Figure 5.3
Estimated emissions of nitrogen oxides, carbon monoxide and hydrocarbons in the United Kingdom, 1971–1981
Values for nitrogen oxides are expressed as nitrogen dioxide equivalent.
Source: Reference (154)

MONITORING

5.7 There are many reasons for needing systematic measurements of air quality, but they mostly fall into three categories. First, some baseline monitoring is needed so that large-scale changes in patterns or trends can be detected. Then there is an increasing requirement for monitoring for administrative purposes, for example ensuring compliance with air quality standards set by European Community directives or checking the effectiveness of emission controls at an industrial plant. Thirdly monitoring is used in many research projects, for example when investigating the dose-response relationship of a crop and an atmospheric pollutant. We fully endorse the view that monitoring should be tied to specific objectives, and it is essential that these are clearly stated at the outset and that the system is then designed to meet them.

5.8 Monitoring is rarely cheap or simple and so it is worth devoting effort to designing the most cost-effective system to achieve a particular objective. While, ideally, a single monitoring network would be used for a variety of purposes, in practice no one monitoring system can fulfil all requirements. When siting measuring stations careful consideration has to be given to the characteristics both of the locality and of the precise position within that locality. The number of measurement sites necessary for a monitoring network depends on the likely spatial variation in concentration of the contaminant being measured and on the purpose of the exercise. Complete spatial coverage of the United Kingdom is usually prohibitively expensive and it is therefore inevitable that many monitoring programmes involve some degree of interpolation and extrapolation of measurements.

5.9 We endorse the present policy([157]) that current and future monitoring requirements should be catered for by two complementary systems. The first system should comprise a baseline network, or networks, to provide a long-term data base for the most important pollutants and comprise a representative selection of sites throughout the country. Additionally, *ad hoc* networks or individual sites are needed for particular purposes, often local, and for shorter periods of time; compatibility of data with the baseline networks is essential. It is also important that there is an overall co-ordination of monitoring activities to avoid unnecessary duplication. With the desirability of this dual approach in mind, we now consider the main aspects of current and planned monitoring systems.

5.10 The Commission's Fifth Report([3]) described the workings of the National Air Pollution Survey which was, and is still, the only integrated monitoring scheme covering the whole country. In 1976, when the Report was published, the Survey was operated at over 1,200 sites with data collected voluntarily by local authorities and other bodies, and with co-ordination and data processing undertaken by the Warren Spring Laboratory of the Department of Industry*. The Report recognised that there was scope for rationalising the network and recommended that the Department of the Environment should assume formal responsibility for the Survey. This recommendation was accepted and the Survey was recently and more accurately renamed the UK Monitoring Networks for Smoke and Sulphur Dioxide(24). Since 1976 this monitoring scheme has undergone considerable change: a baseline network of 175 urban sites has been established, and approximately 20 *ad hoc* networks, comprising approximately a further 295 sites, have been set up mainly in those urban areas where the European Community Directive limit values for smoke and sulphur dioxide (SO_2) are exceeded or approached (see paragraph 5.3).

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*Now the Department of Trade and Industry

5.11 In addition to the 470 or so urban sites there are about 100 sites for measuring smoke and SO_2 concentrations in small communities or open country. However, the number of these rural sites is currently under review and it has been suggested to us by the Warren Spring Laboratory that only 50 or fewer rural sites will be needed for the baseline network. We are concerned that the future structure of the baseline network for monitoring smoke and SO_2 concentrations, which reflects the emphasis given to hazards for human health, makes insufficient provision for rural areas where the effects of SO_2 on crops and natural vegetation may be of considerable importance. The lack of monitoring data from rural areas has been a serious drawback for those engaged in research on the quantification of the effects of air pollutants on crop production(158).

5.12 Several bodies have told us of their doubts about the adequacy of the Monitoring Networks for Smoke and Sulphur Dioxide in relation to European Community Directive 80/779/EEC (see paragraph 5.3). The criticisms concern the number of measurement sites and their location. Ideally the number of urban sites should be increased, but we would not want this at the expense of sites in rural areas. We note, however, that the number and location of sites are considered to be flexible and discussions between the Warren Spring Laboratory and local authorities may lead to adjustments. The Directive prescribes monitoring at sites 'where pollution is thought to be greatest and where the measured concentrations are representative of local conditions'(155). This wording is open to a variety of interpretations. In areas where domestic smoke control programmes are substantially complete, vehicle emissions may produce kerbside smoke concentrations up to three times those 50-100 m away. Criticisms have therefore been made that none of the monitoring stations are located at the kerbside. However, these are countered with the view that the localised concentrations found at kerbsides are unlikely to be representative of local conditions in the general urban atmosphere(159). We are also aware of various criticisms of technical details of the methods used for measurement of SO_2 and smoke. We are pleased to note that the Warren Spring Laboratory is currently examining the scope for improvement of rural measurements.

5.13 In contrast to the well-established networks for monitoring SO_2 and smoke there is little baseline monitoring of other gases. There are, however, a few monitoring stations providing data for the United Nations Economic Commission for Europe's Environmental Monitoring and Evaluation Programme (EMEP) (see paragraph 5.16), and there have also been a number of *ad hoc* networks or sites set up often for only short periods. There is, therefore, a lack of systematic information on the concentrations of contaminant gases on a countrywide basis. While it would be difficult to justify the resources needed for monitoring every atmospheric contaminant which is known to have some adverse effect, there is a strong case for the baseline monitoring of gases such as nitrogen oxides and ozone, since these have been found to be more abundant than previously believed and may cause damage to vegetation at concentrations regularly detected even by the limited monitoring currently undertaken.

5.14 The present baseline network for monitoring nitrogen oxides (NO_x) in the United Kingdom is limited to three sites in south east England, of which two are in inner city areas (one of them at a kerbside) and one is in an area of mixed suburban housing and light industry. Although, in addition, use is made of a mobile measurement facility, we consider the present network to be inadequate. We accept that measurement of NO_x presents considerable technical problems and is expensive(157), and that a baseline network on the scale of that for SO_2 and smoke would be both prohibitively expensive (for example, in terms of manpower and computer time for processing data) and unnecessary, as the spatial variability of nitrogen dioxide (NO_2) is generally less than that of SO_2 and smoke. Nevertheless we believe that a baseline network of about 25 sites is desirable. The European Commission has proposed a Directive with limit values for NO_2(160); if this is agreed by Member States then it is likely that the United Kingdom will need to undertake much more comprehensive monitoring for this gas.

5.15 Ozone at present also has a baseline monitoring network restricted to three sites: an inner city site and a suburban site (which are also NO_x sites) and a site at a rural location in East Anglia. We consider that a baseline network of about ten sites is justified. Ozone is important as a pollutant affecting both man and plants (see paragraph 5.75) and it serves as an index of other photochemical oxidants.

5.16 Monitoring of chemicals in rainfall is particularly important because of the current concern about acid deposition (see paragraphs 5.78-5.96). There is a lack of data on rainfall acidity and on a range of chemical species in precipitation. A baseline rural network of five sites obtains data daily (which is important as the chemical analysis needs to be done promptly and the composition of the rainfall is highly episodic) and two more sites will soon be added. These sites, at which a number of gaseous and particulate substances are also measured, provide the data that the United Kingdom contributes to EMEP. Monthly data on the chemistry of the precipitation are obtained at three sites operated for the European Air Chemistry Network (EACN) by the Meteorological Office. Additionally there has been a considerable amount of *ad hoc* monitoring at about 40 sites mainly in Scotland and the east midlands of England.

5.17 With the growing realisation that acid deposition comprises not only rainfall but other forms of precipitation (including mist) and what is referred to as dry deposition, whereby gases are absorbed or adsorbed and particulates are impacted on surfaces (see paragraph 5.79), it is important that monitoring can distinguish between these modes of deposition. This presents a number of technical problems and it is essential that these are appreciated, and that agreement on solving them is reached between the research scientists who are 'customers' for the data, the Department of the Environment which finances the monitoring, and the Warren Spring Laboratory.

5.18 In conclusion while we welcome the organisational changes which have been made to the National Air Pollution Survey since 1976, and the current philosophy of long-term baseline monitoring networks backed up by additional *ad hoc* networks and sites where necessary, we **recommend** that the Department of the Environment should give greater recognition to the importance of long-term monitoring as a basis for action to improve air quality. We are concerned that not enough attention is being given to monitoring SO_2 in remote and rural areas and we **recommend** that further consideration should be given to the size of the baseline rural network. We also **recommend** that the Warren Spring Laboratory, in liaison with the Department of the Environment and with research scientists who use the data, should continue to improve methodology for the measurement of sulphur dioxide, smoke and the wet and dry deposition of other substances. Finally we **recommend** that the number of sites in the baseline networks for the monitoring of nitrogen oxides and ozone should be increased substantially.

INDOOR AIR QUALITY

Introduction

5.19 Until relatively recently, concern about indoor air quality was largely restricted to occupational exposure in the workplace—a subject which falls outside our terms of reference. However, it is now realised that there may also be problems associated with contamination of air in the home and in enclosed public places such as schools and cinemas, and in motor vehicles(161, 162). This growing awareness comes at a time of decreasing ventilation in homes.

5.20 Decreased ventilation in homes is a consequence of the reduction in the use of open fires for domestic heating, and of the spread of central heating and energy-saving programmes. Fewer houses now have open fires or other forms of heating which make use of traditional fireplaces and chimneys, by which an updraught of air produces a balancing inflow of air to the room through deliberate or fortuitous ventilation gaps. Natural ventilation is an aspect of building performance which is far from fully understood(163). It has been suggested, however, that for a typical house double glazing and weather-stripping of doors reduces the ventilation rate by about 20 per cent([164]). There has been positive promotion of energy conservation within the home and an increase in the expected standard of comfort. Reducing ventilation does cut down heat losses but not to the extent that many people imagine; the Building Research Establishment has estimated that 75 per cent of the heat loss from a typical house arises not by air movement but by conduction through the fabric of the building([165]). Furthermore, the benefit of any energy saving achieved by reducing ventilation may have to be set against a deterioration in indoor air quality([161, 162]) and, particularly when heating and insulation are inadequate, by dampness from condensation and its consequent effects on health and materials([166]).

5.21 The Building Research Establishment recognises that improved guidance is needed on building design, and its current energy conservation research programme embraces these problems([167]). The energy loss associated with ventilation could be reduced if greater use were made in the domestic sector of combined ventilation and heat recovery technology which can be relatively inexpensive to operate, particularly when installed in new houses.

5.22 Indoor air quality is determined by the air quality outside, by emissions within the building and by the ventilation rate. As air is rarely cleaned before it enters the home, contaminants of the outside air will find their way into the building, though generally at concentrations which are lower than those outside([161]). Contaminants from outside also reach the indoor atmosphere on shoes and clothing. This pathway can be particularly important for the transport of substances such as lead([168]) and asbestos([169]) from the workplace to the home.

5.23 Many gases and particulates are emitted to the air within the home, but there is detailed information on only a few of these. Contaminants from building and furnishing materials include radon, formaldehyde and asbestos. A large number of organic chemicals can be detected in the air and result from the increasing use of new synthetic materials in building and furnishing and in consumer products such as aerosols. Under some circumstances domestic cookers, fires and heaters release many of the same gases and particulates as enter buildings from outside. There is little evidence of harm to health from exposure to these substances at concentrations usually encountered in the home. Certain contaminants, however, have attracted particular attention and we consider these in greater detail below. We do not, however, consider the toxic gases which may be produced when building and furnishing materials burn.

5.24 The activities and the very presence of people in a room alter the composition of the air. Tobacco smoke in particular introduces a number of contaminants which cause greater irritation and nuisance to most people([170]), expecially in conditions of low humidity, than any of the other contaminants discussed in this section. Furthermore, recent epidemiological studies have suggested that even 'passive' smokers (non-smokers subject to tobacco smoke in the air) may have an increased risk of lung cancer([171]).

Radon

5.25 Radon is a chemically inert gas and a naturally occurring source of radiation which may become concentrated in the indoor environment. It is estimated that the average annual radiation effective dose equivalent to each person in the United Kingdom from all sources is about 2,390 µSv*(172). Only 530 µSv of this dose comes from artificial sources, of which medicine (mainly X-rays) accounts for nearly all (Figure 5.4). The remaining radiation dose (1,860 µSv) is wholly from natural sources: 800 µSv comes from the decay of radon gas, 380 µSv from terrestrial gamma radiation, 310 µSv from cosmic radiation and 370 µSv from substances within the body (mainly a long-lived isotope of potassium, ^{40}K, ingested in food). Thus radon is the single greatest source of radiation to the general public and provides about one third of the annual dose. It has long been known that occupational exposure to radon in mines is associated with an increased incidence of lung cancer(173) but interest in the exposure of the general population was aroused only in the mid-1970s following research in Sweden and the United Kingdom(174). It can be argued that radon, being of natural origin, is not strictly a pollutant, but exposure of the general population to it is increased by man's activities and so it is proper to consider it here. Most knowledge of exposure to radon has come from

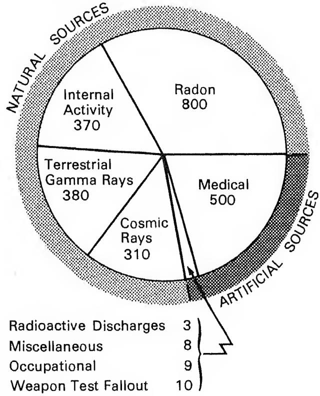

Figure 5.4
Radiation exposure of the population of the United Kingdom
Figures are in µSv and are the annual average effective dose equivalent.
Source: Reference (172)

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*The sievert (Sv) has replaced the rem as the unit of dose equivalent. 1Sv = 100 rem. It is a measure of the energy imparted by ionising radiation to a unit mass of tissue multiplied by a factor representing the harmfulness of the radiation. It provides a common measure of risk for all forms of radiation of the body.

measurements and studies in mines, but the National Radiological Protection Board (NRPB) is now studying radon exposure within buildings. Only recently has it been possible to express exposure to radon in units of dose equivalence whereby its relative contribution to the total radiation dose of the population can be assessed; this has proved a major advance in understanding the importance of radon.

5.26 Radon (Rn) is a radioactive element with a number of isotopic forms, two of which are of significance in the present context. ^{220}Rn is known as thoron as it is an intermediate in the radioactive decay chain of thorium; it is considered further in paragraph 5.28. ^{222}Rn is commonly known as radon and is a more important pollutant. It is an intermediate in the radioactive decay chain of uranium. Uranium, together with its radioactive decay products including radium, occurs as a trace element in all earth materials. Most traditional building materials are derived from earth materials and therefore contain traces of radium. Radium (^{226}Ra) itself decays to radon (^{222}Rn), a chemically inert gas with a radioactive half-life of 3.8 days. In the open air radon is rapidly diluted, but indoors radon from underfloor and building materials can accumulate, with the result that indoor concentrations are usually much higher than those outside.

5.27 The hazard of radon comes from the products produced by its radioactive decay. Radon decays through a chain of several short-lived species which readily become attached to minute solid and liquid particles in the air. These radioactive particulates are inhaled and may be deposited and retained at points in the lungs, around which the tissue is irradiated as a result of further radioactive decay . This can lead to lung cancer and there is evidence that smoking can hasten the onset of the cancer(175).

5.28 Radon is not the only source of radiation within buildings. Thoron (see paragraph 5.26), which has a half-life of less than one minute, also forms radioactive decay products, but the estimated average annual effective dose equivalent from these in the United Kingdom is only 100 μSv (176). Indoors there is also an annual effective dose equivalent of about 340 μSv from natural gamma rays(177) but, unlike that from radon, this is received by the whole body rather than just the lungs. Furthermore, the dose varies little between localities and is hardly affected by house design and similar factors. Hence it is radon on which attention is concentrated.

5.29 It is known that exposure to radon indoors varies considerably between localities and between houses in a given locality. Further information on both the average national exposure and regional variations is being obtained in a survey of over 2,000 homes by the NRPB. The early results suggest that the present estimate of the national annual average effective dose equivalent (800 μSv) is not seriously wrong(177). This figure, however, encompasses wide variations and the dose in some houses in some localities is ten times higher. For the inhabitants of the vast majority of houses in the

United Kingdom the annual effective dose equivalent is less than 5 mSv. It is estimated that in about 100,000 homes there is an annual effective dose equivalent between 5 and 25 mSv, and above 25 mSv in about 1,000 homes(177). For the average person the lifetime risk of lung cancer from exposure to radon is 1 per cent of the risk of lung cancer from all causes and 0.3 per cent of the risk of all cancers from all causes(177).

5.30 In the United Kingdom it has been suggested that action should be taken to reduce annual doses of radon greater than 25 mSv and that doses between 5 mSv and 25 mSv justify further investigation(177). It must be appreciated, however, that there are very great difficulties in identifying homes with excessive radon doses. Whilst it may be possible to identify localities at particular risk, insufficient is known about the variation between houses to predict which particular buildings are likely to have high indoor concentrations of radon. It has nevertheless been suggested that it would be prudent to design new buildings to be within a dose limit of 5 mSv per year(177). These suggestions are compatible with recommendations on limiting exposure to controllable sources of natural radiation that the International Commission on Radiological Protection is expected shortly to announce.

5.31 In houses in the United Kingdom typically 50 per cent of the radon is derived from the ground, about 25 per cent from building materials and 25 per cent from ventilating air (178). Tapwater and natural gas are also sources, but insignificant ones. The nature of the building material is relatively unimportant: granite, for example, produces only twice as much radon as clay bricks. In the houses where radon concentrations are highest the ground is by far the greatest source and so concentrations are generally lower on upper floors. In such houses concentrations of radon and its decay products can be reduced by improving ventilation, both underfloor and within rooms, by sealing floors or ground surfaces, or by direct removal from the air (for example, by air conditioning or electrostatic precipitation). Very little work has yet been done on methods of sealing floors, for example with impermeable membranes, but we are pleased to note that research on this and on other methods of reducing radon concentrations in houses is being undertaken by the Building Research Establishment.

5.32 It is important to be aware of the problem when siting and designing new housing. About 90 per cent of new houses in the United Kingdom would at present meet a design limit of an annual effective dose equivalent of 5 mSv. Sweden and the USSR currently have design limits of about this level for new houses (177). There is, however, the same difficulty in identifying problem sites when planning new housing as there is in identifying existing buildings with high radon concentrations.

5.33 We welcome the research on radon being undertaken by the National Radiological Protection Board and by the Building Research Establishment, and we believe that it will clarify the extent of the problem, identify areas of the United Kingdom at particular risk and provide a better basis for taking whatever action is necessary. We note that the Department of the Environment is currently considering the administrative and legal implications of possible remedial measures for existing dwellings and of controls on new dwellings.

Formaldehyde

5.34 Formaldehyde is used in a wide range of building and furnishing materials, and urea-formaldehyde foam is the most widely used form of cavity wall insulation in the United Kingdom, having been in use for about 20 years. Under certain conditions of temperature and moisture formaldehyde can be released from these materials over long periods. Formaldehyde is also emitted during combustion of most organic materials, including natural gas and other fossil fuels, and is produced in the human body. There are substantial concentrations in tobacco smoke. It can therefore be found nearly everywhere.

5.35 Exposure to formaldehyde produces a variety of symptoms, principally irritation of the eyes, nose and throat(179). There is considerable variation in sensitivity between individuals: eye irritation has been reported in some people exposed to 0.01 mg/m³ formaldehyde for 5 minutes(180), while most reports claim an irritation threshold between 0.25 and 2 mg/m³(179). After long exposure to high concentrations (about 14 mg/m³) there is damage to the nasal tissues of rats and nasal cancer may develop(181). As a result, a Federal Panel in the United States(182) has concluded that formaldehyde should be presumed to pose a carcinogenic risk to man. However, the concentrations causing nasal damage in rats are so high as to be instantly intolerable to man. Epidemiological studies of people occupationally exposed to formaldehyde(181) have failed to detect an increased risk of nasal cancer, but the question of whether formaldehyde may be implicated in other cancers in man is not yet closed.

5.36 Over the last few years there has been considerable publicity given to the alleged hazards arising from the injection of urea-formaldehyde foam into the cavity walls of houses. The production of the foam and its curing *in situ* involve a series of chemical reactions which depend for their success on critical temperature conditions and other factors. If these are not satisfied, some of the chemical reactions may not be completed or may proceed in the opposite direction, releasing formaldehyde gas; whereas if the proper conditions are met only a small amount of formaldehyde gas is formed and much of this will find its way outside the building. A survey in Bolton(183) found that during installation concentrations above the background level of about 0.008 mg/m³ did occur but in all houses where foam installation had been in place for a number of years the air concentration of formaldehyde had fallen to background levels.

5.37 Some countries have recommended maximum values of the order of 0.1 mg/m^3 for indoor formaldehyde concentrations(161). Concern over the emission and effects of formaldehyde led to a ban on urea-formaldehyde foam in Canada in December 1980. The US Consumer Product Safety Commission in 1982 followed the Canadian lead in banning new installations in schools and residences. The ban in the United States was overturned by a Court of Appeals in April 1983 on the grounds that the Consumer Product Safety Commission had failed to provide substantial evidence of an unreasonable health risk. A recent US Government sponsored Consensus Workshop on Formaldehyde has identified the relatively low indoor concentrations of formaldehyde in homes in the United States resulting from the use of urea-formaldehyde foam insulation but the likelihood of higher concentrations over longer periods from other elements of construction, notably chipboard and medium density fibreboard(107). There are considerable differences between building practices in the United Kingdom and North America. In the United Kingdom, British Standards 1142 and 5669 place limits on the emission characteristics of acceptable board products and the use of urea-formaldehyde foam has been confined largely to houses of double masonry cavity wall construction. In North America the foam has been used more widely, and differences in climate and building design (particularly timber buildings with an internal lining highly permeable to vapour) can result in both a greater uptake of water vapour by the foam and a higher ingress of formaldehyde into the building. Furthermore, the United Kingdom has substantial and effective controls covering the installation of cavity wall insulation, in particular British Standards 5617 and 5618 which provide, respectively, a specification for the foam and a code of practice for its installation. These standards were first published in 1978, were updated in 1979, 1981 and again in 1982. Moreover, the Building Regulations were amended with effect from March 1983 to specify more closely the types of cavity construction for which urea-formaldehyde foam insulation is permissible.

Asbestos

5.38 Asbestos is the generic name for several naturally occurring mineral silicates. Their resistance to heat, friction and acid, and their great flexibility and tensile strength have led to their use in a wide range of building materials, vehicle parts and other products. The three main types used commercially are blue asbestos (crocidolite), brown asbestos (amosite) and white asbestos (chrysotile). Imports of raw blue asbestos into the United Kingdom ceased in 1970 and over the last few years imports of brown asbestos have declined to a low level. It is intended to introduce legislation by June 1984 to ban the import of both blue and brown asbestos and the manufacture or supply of products containing them. These measures are more stringent than those set out in a recent European Community Directive (83/478/EEC) on the marketing and use of asbestos(184). Although the amount of white asbestos imported has halved over the last decade, about 50,000 tonnes are imported annually, mainly for use in asbestos cement. Regulations to prohibit the use of white asbestos in thermal and acoustic insulation, and to prohibit the spraying of asbestos, have been proposed by the Health and Safety Executive.

5.39 There are three types of disease which are generally accepted as being associated with exposure to asbestos(169, 185). The first, asbestosis, is a progressive and irreversible scarring of the lungs and is almost entirely associated with occupational exposure. Secondly, mesothelioma is a rare form of cancer affecting the membranes surrounding the lungs or the abdominal cavity; there is strong evidence that it is associated with exposure to blue and brown asbestos, particularly the former, but rarely to white asbestos(186). Thirdly, exposure to asbestos is a factor in the causation of some cases of cancer of the lung itself. The risk of lung cancer among people exposed to asbestos is higher in smokers than in non-smokers. Because of the controls on the import of blue and brown asbestos the health problems related to these varieties of asbestos will become largely self-limiting, except where existing quantities of these types of asbestos are released to the environment, for example by the improperly controlled demolition of some industrial installations. However, since it can be several decades after exposure before these diseases appear, cases of diseases associated with blue and brown asbestos will continue to occur, and the number of cases of mesothelioma is likely to increase, until about the turn of the century.

5.40 Although asbestos fibres can reach the environment from the natural erosion of asbestos minerals, outcrops of these minerals are rare in the United Kingdom and nearly all the asbestos in the environment results from man's use of the material. There are few data on concentrations of asbestos in homes or in the open air: measurements of small quantities of asbestos are subject to large errors and have usually been made by techniques, and in units, which are not comparable with those used in studies of occupational exposure from which our knowledge of the health effects is derived. In one study of buildings in the United Kingdom(187), in which the data could be compared with those from occupational studies, most of the indoor air samples had asbestos concentrations of less than 1 per cent of the present occupational control limit for white asbestos. Concentrations outdoors are usually even lower.

5.41 Exposure to asbestos may arise from a wide range of indoor sources and from some sources outdoors. Many homes contain articles in which asbestos has been used (for example, ironing board pads and oven gloves) and some homes also contain fixtures made of asbestos (for example, fire-resistant linings on doors, and insulation on internal partitions). Many public buildings also contain asbestos, for example in some insulation, in floor tiles and sprayed on to surfaces. Unless asbestos is sealed fibres can be encountered in the air or dust. The worst situation in buildings is where sprayed asbestos (usually blue) has been used as a stucco, since in this form it is subject to abrasion and damage and cannot be sealed effectively. Insulation board may contain a high proportion (40 per cent) of asbestos and this is mainly of the brown kind. Asbestos cement, as used for example in cladding and roofing, is less hazardous as the proportion of asbestos is low and white asbestos is normally used. White asbestos is the form usually found in household articles.

5.42 The likelihood of release of fibres is particularly great when asbestos is being removed. It is essential, for the safety of the public as well as the workforce, that asbestos removal is carried out under very carefully controlled conditions(188). Problems can arise in public buildings when alterations disturb building materials or fixtures containing asbestos. We have noted the widespread public concern which surrounds operations to remove and dispose of large quantities of asbestos from buildings and from industrial plant such as decommissioned power stations. While there is a considerable body of legislation dealing with asbestos in the workplace, there is no specific legislation or statutory code of practice dealing directly with exposure of the public to asbestos, There are, however, a number of regulations by which the public is indirectly protected(189). The Health and Safety Commission's code of practice for work with asbestos insulation and asbestos coating(188) aims to prevent spread of asbestos in air or dust, or on clothing. Local authorities have powers to control asbestos emissions from industrial premises under the provisions of the Public Health Act 1936, the Clean Air Acts 1956 and 1968 and the Control of Pollution Act 1974. The Health and Safety Executive has recently introduced regulations to control emissions from major asbestos works. Protection of the general public during the transport and disposal of asbestos waste is covered by regulations under the Health and Safety at Work Etc. Act 1974 and the Control of Pollution Act 1974. The use of asbestos in the construction of buildings is covered by the Building Regulations 1976, which specify construction standards but do not prohibit the use of asbestos. There is no legislation dealing specifically with the use of asbestos in consumer products, though wide powers exist under the Consumer Safety Act 1978 to regulate the composition of such products. A voluntary labelling scheme was introduced in 1976 and progress has been made in developing substitutes for asbestos in a number of domestic applications. The Department of the Environment has recently issued a booklet for local authorities on asbestos in the home(190), and is preparing guidance notes for the general public. We are satisfied that the Department's advice, if properly followed, is adequate to meet all likely contingencies.

Combustion products

5.43 All indoor combustion sources, whether using gas, liquid or solid fuel, can emit contaminating gases and alter the concentrations of naturally occurring gases (for example, water vapour and carbon dioxide), particularly when the appliance vents its gases internally and when natural ventilation is inadequate. The major contaminants are nitrogen oxides (NO_x) and carbon monoxide (CO). Among the oxides of nitrogen derived from combustion sources it is the nitrogen dioxide (NO_2) that is of prime concern.

5.44 On the basis of the evidence of effects of NO_2 on human health, the World Health Organisation has recommended that a one hour exposure of 190–320 $\mu g/m^3$ should not be exceeded more than once per month by a member of the public(191). Short-term exposure to concentrations above about

50,000 μg/m^3 may be fatal(191). Little is known of the effects of long-term exposure to low concentrations of NO_2, particularly as in epidemiological studies it is difficult to distinguish between the effects of NO_2 and other contaminants in the air.

5.45 There have been several reports from the United Kingdom and the United States, however, of an association between the prevalence of respiratory illness in primary-school children and the use of gas for cooking in the home(192, 193). There has been a major research programme in north east England where concentrations of NO_2 were compared in homes using gas and electricity for cooking. The mean weekly value in kitchens using gas was 211 μg/m^3, compared with 34 μg/m^3 in kitchens using electricity. In the children's bedrooms of these homes the respective mean weekly values were 57 μg/m^3 and 26 μg/m^3. The mean weekly outdoor concentration was 35 μg/m^3(194). A positive, although statistically weak, association was found between the prevalence of respiratory illness and concentration of NO_2 in the bedroom(192). Further investigation produced some inconsistent results and the authors concluded that if NO_2 was the cause of increased respiratory illness its effect was likely to be very slight(195).

5.46 While NO_2 is characteristically a product of high temperature combustion, CO is generally produced by low temperature or incomplete combustion. Moderate concentrations can build up in the indoor atmosphere from gas cookers (especially from faulty pilot lights), from combustion of other domestic fuels, from tobacco smoke and from vehicle fumes in domestic garages. Lethal concentrations can arise from blockages in flues serving fires or boilers, from malfunctioning of flueless appliances and from vehicle fumes within garages. Carbon monoxide reacts with haemoglobin in the blood reducing the oxygen-carrying capacity. Exposure to high concentrations can prove fatal and some accidental deaths from CO poisoning in the home occur every year. For example, in 1979 more than 100 deaths in the United Kingdom were attributed to accidental CO poisoning from gas appliances and a further 30–60 from other domestic fuels(196). There is uncertainty about the effects of long-term exposure to CO(197) and about the symptoms related to poisoning below the level leading to unconsciousness.

5.47 There are few published data on indoor CO concentrations, but it has been suggested that typical indoor concentrations, when emission sources are present, are in the range 5–60 mg/m^3(198). In a study in London of CO concentrations in a normal kitchen, with a gas cooker and natural ventilation, maximum mean concentrations of 18 mg/m^3 and 184 mg/m^3 were measured over periods of 24 hours and 15 minutes respectively(199). Although, for a given CO concentration, it is possible to estimate the likely average increase in the percentage of haemoglobin in the blood which is combined with CO (and so not available to carry oxygen), it is not possible to relate this to health effects at the concentrations mentioned above. The World Health Organisation recommends as long-term goals that exposure to CO should not exceed eight hours at 10 mg/m^3 or one hour at 40 mg/m^3(200).

Conclusions

5.48 We have considered indoor air quality at some length because of recent public concern and because it is an area to which relatively little attention has been paid in the past. Members of the public are exposed to a very wide range of substances contaminating the air in their homes and in other buildings. From none of the substances usually encountered (with the notable exception of tobacco smoke) is there likelihood of damage to health in most circumstances.

5.49 With regard to *radon,* we **recommend** that priority should be given to devising effective remedial measures for those existing houses where radon concentrations are such as to cause anxiety, and to devising preventive measures for new houses. We **recommend** that, when this has been achieved, remedial action on existing dwellings should be undertaken, initially on those where the annual effective dose equivalent exceeds 25 mSv. We also **recommend** that a design limit should be applied to new dwellings. On the basis of information available to us we favour an annual effective dose equivalent limit of 5 mSv, but a decision on the value should await the assessment of recommendations in the forthcoming report on controllable sources of radiation by the International Commission on Radiological Protection.

5.50 While we believe that the Government should monitor closely the results of research on the effects of *formaldehyde* on health and should ensure that the highest standards of installation of cavity wall foam are maintained, we do not see any justification at present for further regulations on the use of formaldehyde or the ending of its use in cavity wall insulation.

5.51 The problems of the most hazardous forms (blue and brown) of *asbestos* concern the removal and disposal of materials which have been used in the past and are still present in buildings. We believe that if the existing codes of practice and guidelines are followed the risk to the general public will be negligible. Builders, whose activities tend in practice to fall outside the scope of routine enforcement of health and safety legislation, and do-it-yourself enthusiasts, may be at risk if they are repeatedly exposed to asbestos-containing materials, particularly in house improvement and conversion work, and it is therefore important that they should be aware of, and follow, the advice which the Department of the Environment has provided. We **recommend**, therefore, that the Department of the Environment should pay particular attention to ensuring, through suitable publicity, that advice on asbestos reaches the important target of smaller builders and do-it-yourself enthusiasts. We believe, however, that there is no appreciable risk to the general public from exposure to asbestos in household articles or in other products containing white asbestos provided that they are in good condition.

5.52 So far as other contaminants are concerned, we believe that vigilance will ensure early recognition of future problems. Finally, we emphasise the importance of ventilation (see paragraphs 5.19–5.21) and we **recommend** that, in parallel with the continuing research into indoor air quality and the role of ventilation in relation to building design, energy conservation and health, central and local government, the Health Education Council and the Scottish Health Education Group should actively promote greater public awareness of the importance of maintaining reasonable ventilation in the home, particularly where flueless heating appliances are in use. Effective insulation to conserve energy should not mean inadequate ventilation.

MOTOR VEHICLE EXHAUSTS

Emissions and their effects

5.53 Ideally there would be complete combustion of fuel in the engines of motor vehicles, and the emissions would consist of water vapour, carbon dioxide and nitrogen. In practice, however, motor vehicles inevitably emit, in varying degrees, a number of other substances, the most important of which from petrol engines are nitrogen oxides (NO_x), carbon monoxide (CO), hydrocarbons, and particulates. In the case of motor vehicles using leaded petrol, the particulates include lead compounds; these emissions were considered in detail in our Ninth Report(7) and are not discussed further here. With diesel engines there are no lead emissions and lower emissions of CO, but when not properly maintained they can emit considerable quantities of smoke from incompletely burned fuel (Plate 8). Smoke emissions consist of small particles of carbon on which hydrocarbons and other gases are adsorbed. The oily smoke not only reduces visibility but blackens stonework (Plate 9)—a continuing problem despite the reduction in smoke emissions from most other sources (see Figure 5.1)(201). Diesel emissions may also have an unpleasant smell due to the presence of oxidation products of hydrocarbons, such as aldehydes, ketones and alcohols.

5.54 There has been increasing attention paid to motor vehicle exhausts and recent reviews have been conducted by the European Community (on petrol-engined vehicles)(202) and in France(203). The significance of vehicle emissions is not only that they may have direct effects on health, the environment and amenity, but also that they contribute to the pool of atmospheric contaminants which can undergo transformations to so-called secondary pollutants (see paragraph 5.72).

5.55 Although both NO_2 and CO are harmful to health at high concentrations (see paragraphs 5.44–5.47), these gases are rapidly diluted on leaving the exhaust pipe and there is no evidence of harmful effects at the concentrations usually encountered in the street. Nevertheless, concentrations of NO_2 and CO in excess of World Health Organisation (WHO) guidelines have been found in the United Kingdom in some urban areas where the traffic density and local topography allow them to build up. A study of background NO_2 concentrations showed a median value of hourly means in rural East Anglia of less than 10 μg/m^3, compared with values of 26–45 μg/m^3 in urban and suburban areas of south east England and 70 μg/m^3 in central London(204). At a kerbside site in central London 2.6 per cent of the hourly mean values exceeded the WHO guideline of 190 μg/m^3 but less than 0.1 per cent exceeded the WHO guideline of 320 μg/m^3(204). Measurements of eight-hourly mean concentrations of CO in London have shown that the WHO recommended maximum exposure value of 10 mg/m^3 has been exceeded at many kerbside sites(205).

5.56 Hydrocarbons are emitted as gases from both petrol and diesel vehicles and as constituents of smoke particles from diesel engines. They also reach the air by evaporation of spilled or leaked fuel. There are many different hydrocarbons present in vehicle emissions: volatile hydrocarbons are of particular importance in relation to the photochemical formation of pollutants (see paragraph 5.73) while less volatile hydrocarbons are associated with particulate matter. Some hydrocarbons, such as methane, are considered harmless while others, such as benzene and some polycyclic aromatic hydrocarbons (PAH), are known carcinogens. Although there is at present no convincing epidemiological evidence of increased incidence of cancers in groups of people particularly exposed to vehicle exhausts(206), we believe that it would be irresponsible to allow an increase in total emissions of carcinogenic hydrocarbons from motor vehicles.

5.57 In our Ninth Report(7) we set out various options for reducing or eliminating lead from petrol. We drew attention to the danger that maintaining the octane level of petrol by further refining or the addition of oxygenates, to compensate for lead additives, could result in an increase in undesirable emissions. For example, maintaining octane level by raising the aromatic hydrocarbon content could result in increased emissions of PAH(207). Recently there have been expressions of concern in the United Kingdom, France and the United States(201, 203), about the likelihood of increased emissions of PAH if the use of diesel fuel increases. The United Kingdom Government has announced its intention of phasing in unleaded petrol by 1990 at the latest(8); it is important to ensure that the course adopted does not involve the increase of hazardous emissions.

Present emission controls

5.58 Emissions from motor vehicles can be regulated by controlling the composition of the fuel or by setting standards for vehicle design and construction. Within the European Community fuel composition is regulated by directives on the lead content of petrol (78/611/EEC)(208) and the sulphur content of gas oil (diesel) (75/716/EEC)(78). There are several directives which set optional standards* for petrol and diesel vehicles.

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*Member States are not obliged to make mandatory the standards laid down in the Directive, but may not withhold type approval from a vehicle on the grounds of air pollution if the standards are met.

5.59 In the United Kingdom gaseous emissions from new motor vehicles with petrol engines are limited by statutory standards of design and construction, but there is no control of gaseous emissions from vehicles once on the road. The standards are based on regulations developed by the United Nations Economic Commission for Europe and have also been adopted by the European Community.

EFFECTS IN THE UNITED KINGDOM OF EUROPEAN COMMUNITY DIRECTIVES REGULATING GASEOUS EMISSIONS FROM MOTOR VEHICLES WITH PETROL ENGINES

Directive 70/220/EEC and subsequent amending Directives (209, 210), which are based on regulations developed by the United Nations Economic Commission for Europe, set standards for vehicle design and construction. Although the directives are intended primarily to prevent Member States raising a barrier to trade by setting more stringent standards than those specified, the amendments have progressively tightened the emission limits specified.

The limits in the Directives, although optional (see footnote to paragraph 5.58), have been made mandatory in the United Kingdom.

The effects of these limits on emissions in the United Kingdom have been estimated in a computer modelling exercise by the Department of Transport (211). It is predicted that when the latest amending Directive (210) has been implemented the average production limits for CO and hydrocarbons will be about 30 per cent and 50 per cent respectively of the values achieved in the late 1960s before the first controls were introduced. Controls on NO_X were not introduced until the late 1970s and it is predicted that the average production limit will reach about 65 per cent of the value then. Taking account of forecasts of vehicle population and mileage, non-compliance and deterioration of performance, it is predicted that the total emissions of CO and hydrocarbons from motor vehicles in the 1990s will approximately equal those in 1965. Total annual emissions of NO_X from motor vehicles in the 1990s are expected to be about 60 per cent of those in 1965.

5.60 Until recently there were no limits on gaseous emissions from motor vehicles with diesel engines. However, the most recent amending directive (210) in the series concerning emissions from motor vehicles with petrol engines (see box) has widened the scope of the series to include construction standards for emissions of CO, hydrocarbons and NO_X from light duty vehicles with diesel engines.

5.61 Strict controls on smoke emissions from vehicles with diesel engines (other than tractors, which are the subject of a separate directive, and some public works vehicles) are set out in European Community Directive 72/306/EEC(212). This imposes not only design and construction standards but also controls on vehicles in use. In the United Kingdom new diesel engines must comply with limits laid down in British Standards, or equivalent international standards, which are designed to ensure that there is barely any visible smoke emitted under all operating conditions. Smoke emissions from heavy diesel vehicles, such as lorries and coaches, are checked at the annual vehicle tests and at random roadside tests.

5.62 The Report of the Inquiry into Lorries, People and the Environment (Armitage Report)(213) recognised that excessive exhaust smoke was a major cause of public complaint against heavy lorries. The Department of Transport (DTp) accepts that there is a problem and estimates that some 14 per cent of lorries emit excessive smoke. Poor maintenance, particularly of fuel injectors, is generally considered to be the major cause. We understand that relatively few vehicles fail the annual test on smoke grounds—perhaps not surprisingly, since most operators will ensure that the fuel system is properly adjusted before submitting a vehicle for test. The difficulty is in ensuring adequate maintenance standards over the very considerable mileage typically covered by these vehicles between tests. A further problem is the absence of an effective device to give an objective on-the-spot measurement of smoke, though the DTp is committed, following the recommendations of the Armitage Report, to develop more objective smoke test methods for use both at testing stations and at the roadside (214). Police prosecutions for excessive smoke number about 7,500 each year (compared, for all vehicles, with about 14,000 for excessive noise and about 391,000 for speeding offences)(215). We have been assured that complaints by the public or by local authority officers about particular vehicles are always followed up by DTp vehicle examiners, but these rarely result in prosecutions. The ultimate sanction against a vehicle is a prohibition notice; this can be issued only by a DTp vehicle examiner and not by the police.

Future emission controls

5.63 Within the European Community there are pressures for general improvements in air quality, particularly in view of the increasing importance attached to problems such as the photochemical formation of oxidants (see paragraph 5.73) and acid deposition (see paragraph 5.78). At present the only air quality standards in force in the United Kingdom are for lead (216), sulphur dioxide and smoke (see box on page 113); these are all set by European Community directives. Proposals for a European Community air quality standard for NO_2 are currently being discussed by Member States*. Several Member States already have national standards for NO_X and CO, but only Italy has an air quality standard for hydrocarbons. In the United States there are air quality standards for all these gases and also for ozone.

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*A draft directive sets an air quality limit value for nitrogen dioxide of 200 $\mu g/m^3$ for 98 per cent of hourly mean values recorded throughout the year. A guide value of 135 $\mu g/m^3$ is also specified(160).

5.64 Motor vehicles make a major contribution to the atmospheric concentrations of most of the contaminants mentioned in the previous paragraph, and further improvements in air quality are therefore likely to require reductions in emissions from motor vehicles. In the Federal Republic of Germany there is a political commitment to require new vehicles to run on unleaded petrol from 1986. A major reason is to allow the use of exhaust catalysts (see paragraph 5.67) to meet strict new motor vehicle exhaust emission standards.

5.65 The relationship between emissions from motor vehicles and the resulting atmospheric concentrations is complex and involves dispersion of the emitted gases, movement by air masses and, in many cases, physical and chemical processes in the atmosphere. The result of these processes is often that the substances in the air which cause harm are not the substances originally emitted but so-called secondary pollutants (see paragraph 5.72) formed by reactions in the atmosphere. Furthermore it does not follow that reduction of emissions of one particular gas in isolation will necessarily produce a reduction of secondary pollutants; while reductions of emissions of hydrocarbons may well reduce the photochemical formation of secondary pollutants (see box at paragraph 5.73), reductions of emissions of NO_X may actually increase it(217). The effects on air quality of particular emission patterns can often be predicted only by sophisticated mathematical models. A recent report to the Commission of the European Communities(202) has reviewed the scientific, technical and economic aspects of the relationships between emissions from petrol-engined vehicles and air quality; this report is likely to be influential in shaping any proposals by the European Commission for the further reduction of emissions.

5.66 Tighter limits on emissions of CO, hydrocarbons and NO_X from motor vehicles are likely to require changes in automobile technology, or at least the introduction of technology not at present used in Europe. It is outside the scope of this report to assess this technology or to make judgments on the relative merits of different systems. We do, however, think it will be helpful to outline two approaches to the further reduction of emissions.

5.67 The use of platinum group metals, in the United States and elsewhere, to catalyse the breakdown of exhaust gases into harmless substances was described briefly in our Ninth Report(7). Lead-tolerant catalysts have been developed which can oxidize CO and hydrocarbons to carbon dioxide and water vapour, but the catalytic reduction of NO_X to nitrogen can be affected only when unleaded petrol is used. The exhaust catalyst systems used in the United States require development to make them suitable for widespread use in Europe. The motor industry has stressed to us the differences in driving practice between the United States and Europe. In Europe the open-road speeds are generally much higher but urban traffic movement is more often congested. The resulting wider range of engine operating conditions in Europe is reflected in the wider range of temperature at which the exhaust catalyst would have to operate. This affects the design of the exhaust catalyst system and, in particular, the catalyst support material, on which further development work will need to be done. There would also need to be a very great increase in the production of platinum group metals; European catalyst manufacturers are confident that there are adequate supplies available in South Africa* to meet the predicted demand([218]).

5.68 The United Kingdom motor industry in its evidence to us ([219]) has been less than enthusiastic about the use of catalysts to reduce emissions. The motor industry generally favours the development of the 'lean-burn' petrol engine concept with new designs of combustion chamber allowing higher compression ratios and a lower ratio of fuel to air†. The result is an engine with high thermal efficiency and, consequently, greatly improved fuel economy and reduction in emissions of CO and NO_X. However, the higher emissions of hydrocarbons and the need for high octane fuel (see paragraph 5.57) raise concern about increased emissions of carcinogenic hydrocarbons.

Conclusions

5.69 We welcome the attention being paid to the environmental, technical and economic aspects of vehicle emissions by the Commission of the European Communities and by other bodies, and we note the relevance of the subject to issues such as acid deposition and the formation of photochemical oxidants. Within the scope of this Report, and given the present state of international activity in this area, we feel it would not be appropriate for us to attempt to reach a definitive view on whether further reductions are desirable, which pollutants deserve priority and by what technical means any reductions are best achieved. We intend, however, to keep these issues under review.

5.70 There are, however, two issues on which we wish to make recommendations. First, we consider it essential that there is no increase in the quantity of polycyclic aromatic hydrocarbons and other carcinogens in motor vehicle exhaust emissions. We therefore **recommend** that the route taken to implement the Government's stated intention to introduce unleaded petrol should not involve an increase in the total amount of carcinogenic hydrocarbons emitted from the vehicle population.

5.71 Secondly, we consider that smoke emissions from diesel vehicles in the United Kingdom are in many circumstances at an unacceptable level. We believe that there is scope for improving both vehicle construction standards and enforcement in use. We **recommend** that the Department of Transport should institute urgently a programme of research into the use of electronic engine control systems and other forms of engine technology to make the quality of emissions from diesel-engined vehicles less dependent on standards of engine maintenance. We also **recommend** that greater urgency should be given to the development of more expeditious and objective methods for the measurement of smoke from diesel-engined vehicles both at testing stations and at roadsides. Finally, we would like to see a strengthening of the resources deployed on enforcement of smoke limits. In keeping with the conclusions of the Commission's Fifth Report (3), we see here an opportunity to involve local environmental health officers, who currently receive complaints which they have to refer to officers of the Department of Transport. We **recommend** that legislative provision should be made to enable local authorities to take proceedings directly against operators of vehicles emitting excessive smoke.

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*Nearly all the world's supplies of platinum group metals are mined, in approximately equal quantities, in South Africa and the USSR.

†A simple account of the workings of the internal combustion engine is given in our Ninth Report([7]).

PHOTOCHEMICAL OXIDANTS

5.72 Some substances emitted to the atmosphere may be harmful in the forms in which they are emitted: examples of such primary pollutants are sulphur dioxide, which can damage plants, and carbon monoxide, which can damage human health. Many atmospheric contaminants, however, can react in the atmosphere to form other substances (secondary pollutants) with properties and effects quite different from those of their precursors. These atmospheric reactions are diverse, complex and incompletely understood; they depend on the identities and concentrations of substances present and on atmospheric, weather and topographical factors. Reactions may take place over long periods of time as an air mass is transported over considerable distances. Secondary pollution is, therefore, not restricted to urban or industrial areas, but is a problem on an international scale.

5.73 Of particular importance is what is termed photochemical pollution. Here a complex mixture of primary and secondary pollutants is formed by the photochemical action of sunlight on contaminants, the main precursors being nitrogen oxides (NO_X) and certain hydrocarbons from industrial sources and motor vehicles. At its most extreme photochemical pollution takes the form of a smog which, while notorious in cities such as Los Angeles and Tokyo and serious in Sydney and Athens, may affect many areas in certain weather conditions. A photochemical smog consists mainly of ozone, aldehydes, peroxyacylnitrates (particularly peroxyacetylnitrate (PAN)) and aerosols (see box). This smog reduces visibility, has an unpleasant smell, is corrosive and has adverse effects on human health and on plants. The United Kingdom does not suffer from the severe and long-lasting smogs of, for example, Los Angeles, but during stable anticyclonic weather in summer elevated concentrations of ozone, PAN and visibility-reducing aerosols (Plate 10) are produced by photochemical reactions in air masses over north west Europe and affect large areas of the United Kingdom (220). Ozone and PAN are often termed photochemical oxidants because of their formation in photochemical reactions and their powerful oxidizing properties.

5.74 Ozone is a natural constituent of the stratosphere (see paragraph 5.97). Downward transport of stratospheric air, together with the small amounts of ozone produced at ground level by natural processes, gives ground level ozone concentrations usually of 60–100 $\mu g/m^3$ and occasionally as high

PHOTOCHEMICAL FORMATION OF POLLUTANTS

The principal reactions leading to the formation of photochemical oxidants involve the action of sunlight on nitrogen oxides and hydrocarbons from motor vehicles and other sources.

Nitric oxide (NO), which is produced in high temperature combustion, is slowly oxidised in the air to nitrogen dioxide (NO_2). The action of sunlight converts nitrogen dioxide back to nitric oxide with the release of oxygen atoms which react with oxygen molecules to form ozone (O_3):

$$\mathrm{NO_2 \longrightarrow NO + O}$$

$$\mathrm{O + O_2 \longrightarrow O_3}$$

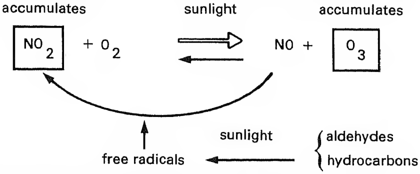
The ozone reacts with nitric oxide to reform nitrogen dioxide:

$$\mathrm{NO + O_3 \longrightarrow NO_2 + O_2}$$

An equilibrium is thus established with no significant accumulation of ozone:

$$\mathrm{NO_2 + O_2 \overset{\overset{\text{sunlight}}{\downarrow}}{\rightleftarrows} NO + O_3}$$

However, this equilibrium is disturbed by other contaminants in the air. The action of sunlight on certain hydrocarbons and aldehydes, of which motor vehicles are major sources, produces free radicals (very reactive chemical species) which convert nitric oxide to nitrogen dioxide and cause the accumulation of both nitrogen dioxide and ozone:



Other photochemical reactions also take place. Peroxyacylnitrates, including peroxyacetylnitrate (PAN), are formed by the reaction between nitrogen dioxide and the products of the atmospheric oxidation of aldehydes; and free radicals can convert nitrogen dioxide and sulphur dioxide to nitric and sulphuric acids.

In addition to these chemical reactions, physical processes cause the formation of visibility-reducing aerosols. Small particles from motor vehicle exhausts and elsewhere produce high concentrations of condensation nuclei which inhibit the growth of larger droplets of moisture which would rapidly fall out of the air. The result is a fine fog of contaminated droplets which reduces visibility, and, by decreasing the amount of sunlight reaching the ground, under some topographical conditions reduces air movements which would otherwise disperse the fog.

as 240 µg/m^3 in particular weather conditions. Monitoring of the lower atmosphere for ozone has been carried out in the United Kingdom for little more than a decade and elevated concentrations due to photochemical reactions were first detected in 1971(221). Concentrations above 200 µg/m^3 are now found frequently, and 400 µg/m^3 was recorded in south east England during the exceptional summer of 1976(222). The long, hot spells of sunny weather in 1983 also favoured photochemical formation of ozone and in London the highest concentrations for several years were recorded(223). In hot summer weather ozone concentrations may build up over a period of time with the affected air mass spreading over extensive areas. Urban areas in north west Europe add ozone to the air mass, but the contributions of the individual sources cannot usually be distinguished. In the United Kingdom it appears that towns with about 75,000 or more inhabitants can act as local sources of ozone(224). A survey in 1977 recorded phytotoxic ozone concentrations (estimated to be 80–100 µg/m^3 or greater) using particularly sensitive indicator plants over the whole of Great Britain south of Aberdeen and for the eastern half of Ireland(224).

5.75 Ozone is a powerful oxidant and low concentrations can be toxic to both animals and plants. At 300 µg/m^3 it may impair the breathing of heavy smokers, asthmatics and those indulging in intense physical activity(225). Observed effects on plants range from visible foliar injury and loss of yield to changes in the plant cells which can only be detected using biochemical techniques(226). Concentrations as low as 80 µg/m^3 over a period of days can cause damage to particularly sensitive plants(227). A survey in 1978 recorded ozone injury to several commercial field crops in the United Kingdom(228). Natural vegetation can also be affected. Ozone has been shown to interact with other pollutants, so that the effect of the combination may exceed the sum of the effects of the individual pollutants acting singly(229). It may be extremely difficult, however, to recognise and estimate ozone damage in the field since ozone does not occur in isolation from other air pollutants. It has been suggested that ozone may have a substantial effect on crop yields in rural Britain, usually without visible symptoms on the plants(230).

5.76 Very much less is known about PAN and other photochemically formed peroxyacylnitrates, and in the United Kingdom measuring of atmospheric PAN has only recently begun. Average winter concentrations in rural Oxfordshire have been found to be about 0.5 µg/m^3, rising to about 3.5 µg/m^3 in August(231). During periods of high photochemical activity on hot summer days concentrations up to about 45 µg/m^3 have been measured in Oxfordshire and about 80 µg/m^3 in London(231). There are few quantitative data on the effects of other individual oxidants, but PAN is believed to have broadly similar effects on animals and plants to those of ozone. From the limited data on man PAN is known to be a strong eye irritant and at 1,350 µg/m^3 it can produce changes in physiological variables that are associated with cardiorespiratory and temperature regulation(232). Although it has been shown that a concentration of 75 µg/m^3 over several hours can produce visible injury to the leaves of particularly sensitive plants(233), there is a lack of information of the effects of background concentrations of PAN on crops and natural vegetation, and on interactions with other pollutants, such as ozone, which invariably are present at the same time.

5.77 Photochemical oxidants, like other secondary pollutants, are difficult to study. Their occurrence and effect on plants in the United Kingdom are only now beginning to be detected and we have little idea of their economic significance. Air pollutants rarely occur in isolation and the effects on plants of a mixture of air pollutants may not be simply additive. It is by no means straightforward to devise control measures as the physics and chemistry of secondary pollutant formation are complex and incompletely understood. Decisions concerning air quality criteria which are based solely on the properties of primary pollutants will be of limited value for secondary pollutants. We **recommend** that the Research Councils should encourage continued research on secondary pollutants, particularly the photochemical oxidants, in the United Kingdom.

ACID DEPOSITION

5.78 Concern about the phenomenon most usually referred to as 'acid rain' first became widespread in the early 1970s with reports of rainfall of increased acidity in the upland areas of southern Scandinavia and in the north east United States. There were fears that this acidity was adversely affecting water quality, freshwater fisheries and forest productivity. The increased acidity was blamed on atmospheric pollutants, not only of local origin but also transported over large distances from their areas of emission. A number of national and international research programmes were set up, notably one by the Organisation for Economic Co-operation and Development to examine the long-range transport of sulphur pollutants in Western Europe(234). In 1976 the field was reviewed, under the auspices of the Department of the Environment(235), and the situations in Scandinavia and the United Kingdom compared. More recently 'acid rain' has again became a matter of considerable debate, particularly in North America and northern and central Europe, and there is a vast and rapidly growing body of scientific literature on the subject.

5.79 The term 'acid rain' is itself rather misleading as the phenomenon is much broader than this suggests. It makes little sense to consider in isolation the effects of rainfall acidified by pollutants when other forms of precipitation such as fog drip and snow may be of at least equal significance. Furthermore, the same pollutants may reach the ground by wet or dry deposition and then have similar effects. Consideration of acid deposition therefore should include wet deposition of pollutants reaching the earth's surface in precipitation, and dry deposition of the same pollutants by adsorption, impaction and sedimentation on land and water surfaces. The common factor is the acidifying effect of the pollutants. For these reasons we favour, and have used, the term 'acid deposition'. It should be noted, however, that even with such a broad definition of the phenomenon it may often be impossible to disentangle the effects on plants or ecosystems of acid deposition, of other atmospheric pollutants (such as photochemical oxidants) and of pollutant interactions.

5.80 The principal gaseous emissions which contribute to acid deposition are of sulphur dioxide (SO_2) and nitric oxide (NO), which is oxidised in the atmosphere to the more toxic nitrogen dioxide (NO_2). A great deal is known about the effects of these gases on plants(236) and it is now generally accepted that the background concentrations found in the United Kingdom reduce the yield of some crops, although the magnitude of the effect is uncertain. These gases can also undergo reactions in the atmosphere (see box), involving other contaminants, which result in the formation of acidified precipitation containing sulphate and nitrate ions. The chemical composition of rain varies with place and time, reflecting differences in pollutant emissions, meteorological conditions and neutralisation locally by ammonia. In the north east United States, for example, the association of acidity with nitrate ions has been found to be greater in winter than in summer(238). Both in northern Britain and in Scandinavia the average annual associations of acidity with sulphate and nitrate ions are about 70 per cent and 30 per cent respectively(239, 240). A better understanding of the relative contributions of different gases to the acidification of precipitation is a pre-requisite to effective control measures.

5.81 Making accurate measurements of the pH of rain presents considerable difficulties. While data on historical trends of rain acidity are fragmented and sometimes of doubtful accuracy, there is evidence of a trend of increasing acidity over the last few decades in parts of Great Britain, in southern Scandinavia and in north eastern United States(235). Measurements have been made of rain acidity in Britain during the period 1978–80. In a study covering northern Britain(240) the mean acidity varied from about pH 4.7 in north west Scotland to about pH 4.2 in north east England and south east Scotland. However, a preliminary survey(241) of most of those parts of the United Kingdom for which data were available detected the most acid rain, with a pH of about 4.1, in southern England. When the volume of rain is taken into account it appears that the largest inputs of acid in rain in the United Kingdom are in parts of Cumbria, and in the southern uplands and west central highlands of Scotland(241); the input is of the same order of magnitude as in the most affected areas of Scandinavia and North America, where severe depletion of freshwater fish stocks have occurred(242, 243).

5.82 The best documented, but nevertheless controversial, effects of acid deposition are on freshwater ecosystems. Freshwaters can be affected by a direct input of acid deposition, surface run-off after rainfall and snowmelt, and drainage through soils. In some regions, such as Scandinavia, snowmelt is believed to be of particular importance producing sudden pulses of contaminated water; this can lead to short-term changes in water chemistry with pH values as low as 3.0–4.0(244). The nature of the bedrock, the buffering* capacity of the water and the properties of the soils of the area draining into the water are all factors which determine the resulting pH of the water:

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*A solution is a buffer when its pH is relatively insensitive to the addition of small amounts of acid or alkali.

CHEMISTRY OF ACID DEPOSITION

Gases, particularly sulphur dioxide (SO_2) and nitrogen oxides (NO_x), are emitted from industrial sources and from urban areas. A proportion of these gases is absorbed by vegetation and materials (dry deposition). The remainder stays in the atmosphere and may be oxidized to acids, particularly sulphuric (H_2SO_4) and nitric (HNO_3) acids:

$$SO_2 \rightarrow H_2SO_4$$

$$NO_x \rightarrow HNO_3$$

The oxidation reactions have complex mechanisms and may involve other gases such as ozone. The acids dissolve in moisture in the air to form hydrogen (H^+) sulphate (SO_4^{2-}) and nitrate (NO_3^-) ions:

$$H_2SO_4 \rightarrow 2H^+ + SO_4^{2-}$$

$$HNO_3 \rightarrow H^+ + NO_3^-$$

Positively-charged ions are known as cations, and negatively charged ones as anions.

Acidity is a function of the concentration of hydrogen ions. Some of the acidity is neutralized by ammonia (NH_3) in the air with the formation of positively-charged ammonium (NH_4^+) ions:

$$NH_3 + H^+ \rightarrow NH_4^+$$

Thus the most usual contaminating ions in precipitation (wet deposition) in polluted regions are H^+, NH_4^+ and SO_4^{2-}, NO_3^-. In addition the combustion of certain coals produces substantial amounts of chloride (Cl^-) ions. The total cationic and anionic charges will be equal. If a correction is made for the amount of NH_4^+ present (and for ions from natural sources, mainly seawater), the amounts of SO_4^{2-}, NO_3^- and Cl^- can be used as indices of acidity, although strictly it is the concentration of H^+ ions that is the precise measure of acidity.

pH is the scientific measure of acidity. pH 7.0 is neutral. Higher values represent increased alkalinity and lower values increased acidity. The pH scale is logarithmic and an increase of one represents a tenfold decrease in the concentration of hydrogen ions.

Uncontaminated rain is slightly acidic due both to dissolved carbon dioxide and to naturally occurring acids, particularly of the sulphur cycle. It is probable that the pH of uncontaminated rain varies considerably, but an average value of about pH 5.0 (i.e. slightly acidic) has been suggested(237).

equivalent inputs of acidity can have markedly different effects on the pH of waters in different areas. Acid deposition can affect more than simply the acidity of freshwaters. It can be responsible for the mobilization of toxic metal ions, such as aluminium, from soils and their release to freshwaters. However, other factors, for example natural soil acidity and changes in agricultural or forestry practices, may also contribute to the acidification of freshwaters(245).

5.83 Increased acidity and other chemical changes in freshwaters can have considerable effects on the biota. Particular attention has been paid to fisheries and, in recent decades, there have been many claims of declining catches, particularly in Scandinavia. There is a large body of data on the effects of water chemistry on fisheries, and on the fisheries status of individual lakes of known pH in Europe and North America(243, 246). Successful fisheries can usually be established in waters of pH between 6 and 9. Below pH 5.5 the productivity of fisheries is usually reduced, and below pH 5 there may be impairment of physiological and reproductive processes in fish. Fish eggs and fry are particularly susceptible to acidic water. Few fish species can tolerate water below pH 4(243, 246). Not only fisheries are affected by acidification of waters: there are many reports of changes in the composition of other communities, for example reduction in the species diversity of invertebrate animals and excessive growth of some algae and mosses(239, 247).

5.84 While most records of the effects of acidification of freshwaters have come from Scandinavia and North America, we are aware of increasing evidence of effects in the United Kingdom. In their evidence to us many of the English water authorities, and their counterparts in Wales and Scotland, have expressed concern about acidification of lakes and rivers and associated effects on the biota. There are records, particularly in parts of Wales and Scotland where the underlying rock has a low capacity to neutralize acidity, of waters with a pH below 5(48, 248, 249). There are also reports of declining fish stocks in these areas and of fish mortalities with no obvious assignable causes(250, 251). There is circumstantial evidence that in at least some cases acidity is implicated in the effects on fish, but the process of acidification may be associated with land management changes, particularly coniferous afforestation (Plate 11)(48, 249, 250). In general, data from the United Kingdom on acidification of freshwaters are patchy and of variable quality, and it is unfortunate that only recently has a substantial research effort been started on the association between acidity in precipitation, afforestation and acidity in freshwaters.

5.85 The effects of acid deposition on terrestrial ecosystems are much less clear. Most attention has been focused on forests, but there is still considerable controversy about the effects of acid deposition on both deciduous and coniferous trees. There is an extensive body of knowledge about the effects of gaseous pollutants on plants, including trees(236), but mainly at concentrations greater than are usually met in rural areas. The concentrations in most rural areas in the United Kingdom may cause changes in productivity which are difficult to detect in the field, but there is a lack of unequivocal evidence either supporting or disproving harmful effects of acid deposition on forest tree growth and performance. Some effects have been reported, but overall trends are either unclear or too small to be separated from the natural variation in growth due to climatic influence. In the opinion of the Forestry Commission acid deposition is unlikely to pose an immediate threat to forestry in the United Kingdom(252).

5.86 The postulated effects of acid deposition may be directly on the foliage or indirectly through the soil. Effects on soil are very much dependent on buffering capacity and other soil properties. Many natural processes provide acid inputs(245) and the detection of effects in the field is both difficult and slow. In some soils deficient in sulphur, airborne contaminants containing this element may have a beneficial effect, while in some circumstances nitrogen oxides in the air may act as plant nutrients(253). In upland areas, in particular, forests may be effective in intercepting acid gases and moisture(254), with a resulting increase of acidity of precipitation between the canopy of the crop and the soil(255). There is, as yet, no hard evidence of detrimental effects of acid precipitation on soils in the United Kingdom, but our lack of understanding of many of the processes prevents making predictions with any confidence.

5.87 Considerable publicity has been given to reports of death and dieback on a large scale of trees in deciduous and coniferous forests in parts of the Federal Republic of Germany and elsewhere in central Europe. One hypothesis(256), which has gained some support, is that this phenomenon is due to the combined effects of acid precipitation, heavy metal pollution and dry deposition of sulphur dioxide, which induce a series of events in the trees and the soil, including the mobilisation of soil aluminium which causes damage to the roots. However, there is considerable disagreement over the extent and causes of damage to forests in the Federal Republic(252, 257) and alternative hypotheses involve not only acid deposition but other atmospheric contaminants such as ozone(252, 258). We understand that populations of soil-dwelling animals, such as earthworms, in soils of the affected forests are sometimes at low levels. This could reduce aeration in the upper layers of the soil, but it seems unlikely that it could be due simply to acid deposition.

5.88 The international implications of acid deposition are greater than those of most other pollution issues. This is largely because of the dispersal of many of the contributing gases over long distances(234) and because the countries with the greatest emissions of these gases are not those most severely affected. There is understandable resentment in Scandinavia because most of the precursors of acid deposition are emitted in other European countries; there is a similar situation in Canada, which claims to be affected by emissions from industrial parts of the northern United States(259).

5.89 There are many sensitive ecosystems which may be in danger of damage from acid deposition even though they are a considerable distance away from major sources of atmospheric contaminants. Although our understanding of the long range transport of atmospheric pollutants has increased considerably in recent years(234) there are still many unanswered questions. The relative importance of dry, gaseous deposition is often unknown, although it is thought to be of greatest significance close to emitting sources. Also unclear is the relative impact of long-term depositions with average concentrations of acid components, and short-term episodic depositions of particularly high acidity(260). It is easier to model long-term depositions taking account of prevailing wind speeds and directions. However, short-term episodic depositions may be of greater importance and these are less likely to be related to prevailing winds; thus simple consideration of prevailing winds may not be a reliable way of determining which countries are the source of those emissions responsible for the greatest damage.

5.90 Although there are many uncertainties and disagreements over the nature and extent of damage due to acid deposition, there is now general agreement that emissions of sulphur and nitrogen oxides, and other substances, due to man's activities, are causing some damage to freshwater and terrestrial ecosystems. However, because of incomplete knowledge of the long-range transport of gases and of their atmospheric reactions, there is a lack of agreement about the methods by which the effects of acid deposition can be prevented or reduced. Other than local and short-term measures, such as liming of water bodies and land, the only effective actions will be to reduce the emission of gases which lead to the acid deposition. This view lies behind the intention of the Federal German Government to reduce emissions from motor vehicles (see paragraph 5.64) and the proposed European Community Directive on the control of air pollution from industrial plants(261).

5.91 Particular attention has been paid to the emissions from those power stations which burn fossil fuels. In the United Kingdom approximately 63 per cent of sulphur dioxide (SO_2) emissions and 46 per cent of nitrogen oxide (NO_x) emissions are from power stations (154) and they are therefore the most obvious targets when examining the scope for making reductions in emissions. However, the Central Electricity Generating Board (CEGB) has suggested to us(262) that hydrocarbon and photochemical oxidant concentrations are the main determinants of the rate of conversion of SO_2 and NO_x to acids in the atmosphere and hence that the relationship between SO_2 emissions and acid deposition is not proportional and that reductions in SO_2 emissions from power stations would have little effect in reducing precipitation acidity. This view has been disputed(263). A recent study by the National Academy of Sciences in the United States(264) has concluded that there is a proportional relationship between emissions of SO_2 and NO_x and acid deposition over the eastern half of the United States, when large areas and timescales are considered, so that a 50 per cent reduction in emission of these gases would yield a 50 per cent reduction in acid deposition. However, because of differences in emissions and climate the conclusions of this study cannot automatically be applied to Europe.

5.92 Despite the uncertainties over the origins and effects of acid deposition, it is now accepted by the United Kingdom Government that the long-range transport of SO_2 and NO_x may make an appreciable contribution to acid deposition in other European countries, and that decisions on future control policies must take this into account. The United Kingdom, along with all the other Member States of the European Community*, has ratified the 1979 Geneva Convention on Long-Range Transboundary Air Pollution(265). Contracting parties to the Convention are required to draw up policies and strategies to combat emisson of atmospheric pollutants using the most advanced technology available. The reduction of emissions of SO_2 and NO_x from power stations is limited by economic rather than technical factors. The available technology and estimated costs were reviewed by the Commission on Energy and the Environment(129) and more recently for the Government by the CEGB. The best developed technology is flue gas desulphurisation which is already widely used in Japan and the United States and is being installed in new coal-burning power stations in the Federal Republic of Germany. However, the CEGB predicts that few, if any, fossil-fuelled power stations will be built in the United Kingom this century. Therefore substantial reductions in emissions from power stations could be achieved in the near future only by retrofitting flue gas desulphurisation equipment to existing fossil-fuelled power stations.

5.93 Currently some 2·4 million tonnes of SO_2 are emitted from CEGB power stations each year. Estimates of future trends depend critically on assumptions made about economic growth and the development of nuclear power in the United Kingdom. However, the CEGB considers(262) that for modest economic growth† and a medium development of nuclear power SO_2 emissions in 2000 will approximately equal those at present. The CEGB has estimated that it would take ten years to retrofit its ten largest coal-fired power stations (which in 1982 accounted for approximately 60 per cent of electricity generated by the CEGB from fossil fuel) with flue gas desulphurisation equipment. The capital cost would be approximately £1,500 million (at 1982 price levels) and about 50 per cent of the present total CEGB emissions of SO_2 could be removed by this action. According to the CEGB the increased generation cost would amount to a 10–15 per cent increase at each power station fitted with flue gas desulphurisation. The increase in the cost of electricity to the CEGB's customers is much more difficult to predict, but the CEGB has very tentatively estimated a figure of about 6 per cent. As far as we can judge, these numbers are reasonably well supported by estimates made in an independent study in 1981(266). To put the figure of 6 per cent in context, we note that during the last nine years the retail price of electricity has increased on average by about 4 per cent per year more than have retail prices in general. Further costs would be incurred by retrofitting equipment designed to make a major reduction in NO_x emissions also.

5.94 The CEGB is also examining options for reducing sulphur emissions based on technology which should be available in five or ten years time. These include advanced methods of coal cleaning, coal gasification and fluidised bed

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*At the time of writing Greece had only signed the Convention and had yet to ratify it.

†The CEGB's scenario presumes medium world economic growth and energy prices, a continuation in the United Kingdom of a gradual decline of the importance of the industrial sector and an increase in the importance of the service sector, and a partial success in overcoming the United Kingdom's economic difficulties.

TABLE 5.1

Estimates presented by the Central Electricity Generating Board of the costs of the options available for reducing emissions of sulphur dioxide from power stations

		SULPHUR REDUCTION			*ESTIMATED COSTS*		*SPECIFIC COSTS PER TONNE OF SO_2 ABATED*		
OPTION	*Annual coal tonnage affected M tonnes*	*Sulphur removed K tonnes/ annum*	*SO_2 abated K tonnes/ annum*	*% of CEGB emission*	*Capital cost £M*	*Gross operating cost** £M per annum*	*Capital investment £ per tonne per annum*	*Gross operating cost** £ per tonne*	*Net operating cost £ per tonne**
That might be specified now									
1. Exchange higher sulphur coal for lower sulphur UK coal	5	40	80	2.9		10–15			125–188
2. Exchange higher sulphur coal for low sulphur imported coal	5	81	162	5.8		(No additional cost anticipated)			
3. Reduction in sulphur content of fuel oil (from 3% to 1%)	8 mtce	90	180	6.4		(Costs not estimated by CEGB)			
4. Extension of current coal preparation techniques	11½	22–40	45–80	1.6–2.9	45–50	10–20	560–1,110	125–440	0–190
5. Provision of flue-gas desulphurisation plant:									
(a) Wellman-Lord process on one 3 × 660 MW station	~4	68	136	4.9	117	23.6	860	173	147
(b) Wellman-Lord running at lower removal efficiency	~4	43	86	3.1	86	13.9	1,000	161	119
(c) Wellman-Lord retrofitted to one 4 × 500 MW station	~4	72	144	5.1	152	24.0	1,055	167	128
(d) Limestone/gypsum process on one 3 × 660 MW station	~4	68	136	4.9	117	17.9	860	132	n.a.
That might be specified 5 years hence									
6. Retrofit of advanced techniques to existing coal preparation plants	11½	35–70	70–140	2.5–5.0	55–80	20–30	390–1,140	140–430	60–260
7. Extended use of advanced coal preparation techniques	11½	45–110	90–220	3.2–7.9	70–85	20–30	320–940	90–330	40–210
8. Sea-water FGD process on one 3 × 660 MW station	~4	68	136	4.9	55	16.1	404	118	118
9. Direct injection of limestone to furnaces		(Not quantifiable at present—current view is that it could be more expensive and less effective than FGD processes)							
That might be specified 10 years hence									
10. Pressurised fluidised bed/combined cycle systems with limestone addition	(Not quantifiable at present—US estimates suggest 80% sulphur removal may be attained at specific costs similar to those for FGD processes)								
11. Gasification/combined cycle systems			(Not quantifiable at present—but high (>90%) sulphur removal attainable)						
12. Alternative advanced coal preparation techniques e.g. magnetic separation of pyrites from coal		(Not quantifiable at present—possibly similar performance to 7 above but could be less costly)							

*Assumes an incidental benefit of £1 per tonne of coal burned in the case of the coal preparation options and assumes the sale of by-products in appropriate FGD options.

**Annual cost excluding capital charges.

Source: Reference (262)

combustion. The CEGB favours such methods of reducing emissions rather than flue gas desulphurisation, which it describes as 'expensive, wasteful of energy, and by its consumption of raw materials and waste production, damaging to sections of the environment other than air'(262). The CEGB has provided an analysis of the options, on different timescales, for reducing SO_2 emissions, and this is shown in Table 5.1.

5.95 We accept that the costs of making substantial reductions in emissions of nitrogen and sulphur oxides from power stations in the United Kingdom, whether by currently available technology or future technology, are likely to be high. It is very difficult, however, to compare these estimated costs with estimated benefits of abatement, particularly as the beneficiaries need not be in the same country as those who incur the abatement costs. The Organisation for Economic Co-operation and Development(267) tentatively estimated in 1982 that the benefits in the OECD European countries as a whole lay in the range of £80 to £800 per tonne of SO_2 removed. These figures were arrived at by considering the economic value of health effects, corrosion of materials, crop damage and acidification of waters. Such estimates involve great practical and methodological difficulties, and the range of uncertainty is very wide, but the study provided important indications of where costs occur. It showed that the health costs are the largest but subject to the greatest uncertainty.

5.96 Acid deposition is one of the most important pollution issues of the present time. We are aware of the rapid pace of developments, both scientific and political, and we welcome the recent announcement of an international research programme on the effects on Scandinavian fisheries, to be run by the Royal Society of London, the Norwegian Academy of Science and Letters and the Royal Swedish Academy of Sciences. We do not feel able to make detailed recommendations on the basis of our brief study, but we intend to keep abreast of developments and we may consider the subject again in the future. In the meantime we **recommend** that high priority should be given to research on acid deposition, in particular on the causes and effects, on the interaction with other pollutants, and on remedial action. We consider in paragraph 5.133 *et seq*. the implications if this research demonstrates the need to make a major reduction in the use of fossil fuels. In a general study of this nature it has not been practicable for us to undertake a detailed assessment of SO_2 abatement options or of the costing of these as estimated by the CEGB (Table 5.1). However, recognising the United Kingdom's international obligations (see paragraph 5.92) and the technical and economic advantages of a carefully phased programme over a reasonable timescale (see paragraph 6.40) we **recommend** that the Central Electricity Generating Board should introduce on a pilot basis, over the next five years, certain of the sulphur dioxide abatement options that are already available. It is in our view prudent to do this, not least to gain appropriate technical experience and to encourage relevant innovations in British industry. Otherwise, international pressures may eventually dictate a significant reduction in emissions of SO_2, with the adoption of expensive 'crash programmes' against a background of technical inexperience and of a need for importation of equipment from countries that have already embarked on a programme of abatement.

STRATOSPHERIC OZONE DEPLETION

Stratospheric ozone

5.97 Ozone occurs naturally in the atmosphere, but in trace amounts: the total is equivalent to a layer 3 mm deep at ground level. However about 90 per cent is found in the stratosphere, thinly spread at altitudes between 15 and 50 km (Figure 5.5). In the upper stratosphere the action of ultraviolet (UV) solar radiation on oxygen molecules continuously forms ozone. This is balanced by its destruction in reactions with atoms of oxygen or catalysed by a range of other trace gases occurring in the atmosphere. A natural dynamic equilibrium concentration of ozone is thus found in the stratosphere, but this varies with position, especially latitude, and season.

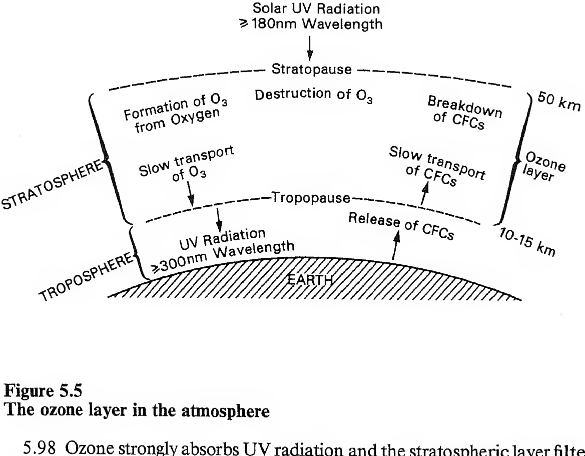

Figure 5.5
The ozone layer in the atmosphere

5.98 Ozone strongly absorbs UV radiation and the stratospheric layer filters out much, though not all, of the solar UV radiation which otherwise would reach the Earth's surface. The amount of UV radiation which does penetrate the stratosphere and reaches the ground depends on the amount of ozone in the stratosphere at a particular place and time. It is reasonable to expect that any reduction of the ozone content of the stratosphere will lead to an increase in UV radiation reaching the ground. Such an increase in UV radiation could have effects on human health and on climate.

5.99 The first concern about depletion of stratospheric ozone was expressed in the early 1970s, when it was suggested that emissions in the stratosphere of nitrogen oxides in the exhausts of the growing numbers of supersonic aircraft would increase the rate of catalytic destruction of ozone. It is now accepted that any such effect is minor and too small to be detected by existing techniques. At about the same time, man-made chemicals known as chlorofluorocarbons (CFCs), which are used for a variety of purposes including refrigeration and as aerosol propellants, were first detected in the atmosphere. These CFCs are extremely stable (as their uses demand) and, unlike most other atmospheric contaminants which are removed from the troposphere by physical or chemical processes, they eventually find their way upwards to the stratosphere. Here, however, they are broken down by the action of solar radiation to produce chemical species which catalyse the destruction of ozone(2,268). Concern at the usage of CFCs has grown but there is still considerable uncertainty about the magnitude of their effect on stratospheric ozone. A Co-ordination Committee for the Ozone Layer has been set up within the framework of the United Nations Environment Programme and negotiations are taking place for a global convention on the protection of the ozone layer.

5.100 Over the last decade very considerable scientific effort has been devoted worldwide to the study of stratospheric ozone and the possibility of its depletion by contaminants. The early work was dominated by a computer modelling of stratospheric chemistry and dynamics, but has now been complemented by laboratory studies of chemical reaction kinetics and by direct atmospheric measurements of CFCs and other trace gases. These studies have contributed greatly to knowledge of the behaviour of the atmosphere. They have also demonstrated the complexity of the issues. For example, different CFCs show different physical and chemical behaviour and there are many contaminant and other trace gases involved in the reactions. Superimposed on all this is a considerable natural variability of the amount of ozone in the stratosphere.

5.101 The computer models have been used to predict the extent of ozone depletion. Most of these predictions have assumed a continuing release of CFCs 11 and 12 (the two CFCs which account for almost 90 per cent of CFC use) at 1976 levels. As the models have been fed with new and revised data over the years, there have been wide fluctuations in the predicted ozone depletion. It is quite possible that the estimates will continue to fluctuate as new research data are incorporated into the models and as modelling techniques are developed to take better account of air movements as a function of latitude, longitude and altitude. According to the most recent predictions an equilibrium state with a depletion of 3-5 per cent will be reached after 50 years or more(269). Such an overall figure incorporates a net redistribution of ozone with altitude, with the depletion most marked above 30 km. It should be noted, however, that the release rates of CFCs 11 and 12 have been declining in recent years: in 1980 the figure was about 15 per cent less than in 1975 (Figure 5.6).

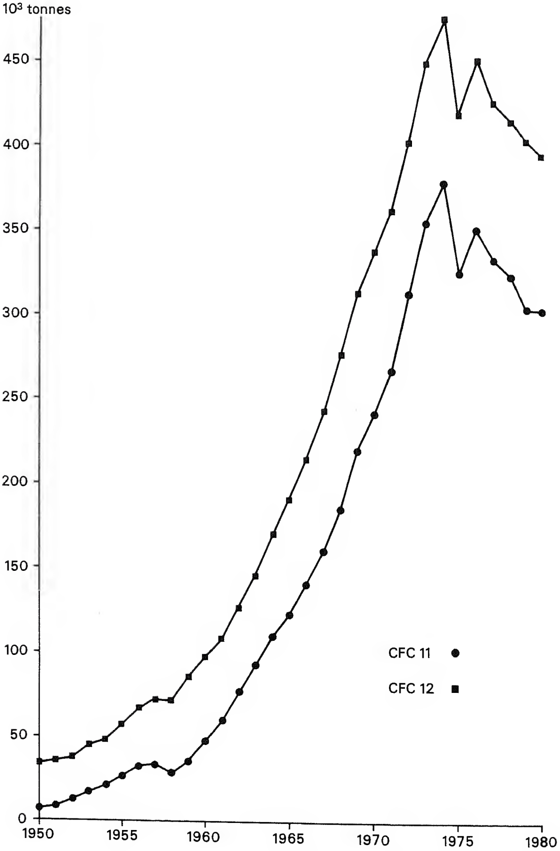

Figure 5.6
Estimated annual global production of chlorofluorocarbons 11 and 12
Source: Reference (270)

5.102 The results of recent modelling exercises suggest that to date there has been a stratospheric ozone depletion of less than 1 per cent(269,271). Unfortunately it is not yet possible to make a convincing test of these models by comparison with observed measurements of ozone. This is because of natural short-term variations in ozone concentrations and of shortage of accurate observational data. The best that can be said is that current observational data are not inconsistent with model predictions.

5.103 It is now known that other gaseous emissions can also affect the natural equilibrium of ozone in the stratosphere, and increasing attention is now being paid to them. Although most contaminants are removed by physical or chemical processes before they reach the ozone layer, some other halocarbons*, methane and nitrogen oxides do reach the stratosphere and are likely to add to the effects of CFCs in depleting stratospheric ozone(269, 271, 272). On the other hand carbon dioxide from fossil fuel combustion and nitrogen oxides from aircraft lower in the troposphere may indirectly cause an increase of stratospheric ozone. It is therefore all the more difficult to predict changes in stratospheric ozone concentration or to assign particular causes to such changes if and when detected.

5.104 The postulated effects of stratospheric ozone depletion are on climate as well as on UV radiation. Several modelling studies have predicted that uniform decreases in ozone concentration in the stratosphere of around 25 per cent or more could produce slight cooling of the troposphere and this, in turn, could have appreciable effects on climatic systems(273). Probably more significant climatic changes would follow changes in the vertical distribution of ozone.

Ultraviolet radiation

5.105 Ultraviolet (UV) radiation with wavelengths between about 300 and 400 nm† reaches the surface of the Earth. UV radiation of wavelengths greater than 320 nm is believed not to be harmful to man or other forms of life and the amount reaching the Earth's surface is not sensitive to changes in the ozone concentration in the stratosphere. UV radiation of wavelengths between 300 nm and 320 nm, which falls in the part of the spectrum known as UV-B, has harmful effects on life and the amount of this radiation reaching the surface is dependent on the amount of stratospheric ozone. Until recently there was a general acceptance that for each 1 per cent of ozone reduction there would be an increase of about 2 per cent in incident UV radiation. However, this relationship is known to vary with the wavelength of the radiation and the general factor of two is an oversimplification(271, 274). Modelling studies have related significant temporal and spatial variations in ozone depletion to UV radiation intensity, with the largest depletions at high latitudes and during winter(274). Therefore when predicting effects on UV-B radiation allowance for the variations in ozone depletion in time and space is of the greatest importance.

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*Substances composed of carbon and one or more halogens (fluorine, chlorine, bromine and iodine). CFCs are halocarbons.

†1 nanometre (nm) = 10^{-9} metres (m).

5.106 UV-B radiation has both beneficial and harmful effects on man. On the positive side the whole population gains from the action of UV radiation in converting steroids in the skin to vitamin D. However exposure to UV-B radiation can also cause sunburn, snowblindness and types of skin cancer. Sufficient medical evidence now exists on the relationship between exposure to UV-B radiation and the incidence of basal and squamous cell skin cancer for this to be considered the most serious health effect likely to arise from depletion of the stratospheric ozone layer. Evidence linking UV-B radiation with malignant melanoma, a much more dangerous skin cancer, is inconsistent and inconclusive(271). However, dose-response relationships are difficult to determine. Not only does UV-B radiation vary greatly with latitude, but epidemiological studies are made extremely difficult by genetic and social differences between populations in different areas. Furthermore there have been trends in social habits, for example in dress and holiday localities, which are likely to be of far greater significance than ozone depletion in affecting an individual's exposure to UV-B radiation. While we are not aware of equivalent calculations for the United Kingdom, it has been predicted that in the United States a 1 per cent decrease in stratospheric ozone will produce a 2-5 per cent increase in the incidence of basal cell skin cancer and a 4-10 per cent increase in the incidence of squamous cell skin cancer(271).

The role of chlorofluorocarbons

5.107 Concern about the effects of CFCs on the stratospheric ozone layer has led to calls for their control or even banning. CFCs were first developed half a century ago as refrigerants and after the Second World War there was a rapid development of their use in aerosol technology. They are also used as solvents, in fire extinguishers, in the foaming of plastics and in the manufacture of other chemicals.

5.108 Estimates of worldwide production of CFCs 11 and 12 are shown in Figure 5.6. Although at present all CFCs are eventually released to the atmosphere, there is a time gap between production and release. The release from aerosols, for example, is rapid but from refrigerators and some foamed plastics it may be delayed or occur gradually over a number of years. Table 5.2 shows the sales of CFCs 11 and 12 in different parts of the world in 1976 and 1979, and Table 5.3 breaks down the sales figures within the European Community by end use.

TABLE 5.2

Worldwide sales of chlorofluorocarbons 11 and 12

	1976		1979	
	Sales	%	Sales	%
European Community	244.0	33.7	219.6	34.0
United States	289.0	39.9	164.9	25.5
Rest of world	191.8	26.5	262.1	40.5
TOTAL	724.8	100.0	646.6	100.0

Sales figures are in 10^3 tonnes.
Source: Reference(275)

TABLE 5.3

European Community sales of chlorofluorocarbons 11 and 12

End use	1976	1977	1978	1979	1980
Aerosols	176.9	162.6	150.4	136.6	126.4
Refrigeration	20.8	20.3	20.4	20.3	21.2
Foams	42.2	45.3	54.5	55.8	61.9
Others	4.2	4.9	6.1	6.9	7.4
TOTAL	244.0	233.0	231.4	219.6	216.8

Figures are in 10^3 tonnes.
Source: Reference(275)

5.109 The United States introduced a ban on the non-essential use of CFCs in aerosols (for example deodorants, polishes, hair lacquer and paint), which became effective in 1979. In 1980 the Council of the European Communities issued Decision 80/372/EEC(276) which stipulated that the production capacity for CFCs 11 and 12 should not be increased in any Member State and that by the end of 1981 there should be a reduction of at least 30 per cent in the use of CFCs in aerosols compared with 1976 levels. During this period a reduction of about 35 per cent was achieved. A re-examination of the situation led to a further Decision (82/795/EEC) which confirmed the obligation not to increase the production capacity, but defined the production capacity (as at March 1980) as 480,000 tonnes per annum(277). In the United Kingdom the target reductions were achieved by voluntary agreement with the manufacturers and trade associations. It is uncertain, however, to what extent the achievement of the target reduction, in the United Kingdom and other Member States, was due to the Decision or to economic factors coupled with scientific and public concern about stratospheric ozone depletion(25).

5.110 The decrease in recent years of the use of CFCs in aerosols, both in the European Community (Table 5.3) and the United States, has been accompanied by a marked increase in other uses, particularly the manufacture of foamed plastics. If the European Community decides to extend its restrictions on CFCs to these other sectors there are likely to be problems for industry, which may not be able to develop adequate substitutes as it has done in the case of aerosols.

5.111 Although production of CFCs 11 and 12 has declined slowly over the last few years both in the European Community and in the United States, there has been an increase in production elsewhere (Table 5.2), for example in Eastern Europe, India and Argentina. Regional reductions are of no consequence if the global use is maintained or increased; effects of CFCs on stratospheric ozone are on a global scale.

5.112 If the consequences of CFC release are considered to be sufficiently serious then, ultimately, regulation might be needed not only for all uses of CFCs 11 and 12 but also for a wide range of other halocarbons, including methylchloroform (1,1,1-trichloroethane) which is widely used in engineering as a non-toxic metal degreaser and whose production has been rising rapidly over the past few years(278). In practice, it is likely that further major reductions in global emissions will be required only if convincing evidence is established of ozone depletion due to man's activities. Advice would then be needed on how the depletion of the ozone layer could best be minimised whilst limiting the damaging effects on industry of further regulation.

Conclusions

5.113 The issue of stratospheric ozone depletion is one which the Royal Commission has kept under regular review since it was raised in the Fourth Report(2). The last few years have seen a reduction in scientific concern about stratospheric ozone depletion and the associated increase in UV-B radiation. The most recent calculations suggest that no significant change should be expected in the total column of ozone until well into the next century, but that some redistribution in the vertical profile would occur earlier(269). There has been a growing realisation of the importance of considering the effects not only of CFCs 11 and 12, but of other halocarbons and other gases which can influence stratospheric chemistry. The problem of stratospheric ozone depletion is still considered to be a real one, but no longer one caused simply by CFCs.

5.114 We believe that there is a need for continuing research and reassessment of the data, particularly taking into account the effects of gases other than CFCs 11 and 12. Of the gases which may contribute to stratospheric ozone depletion some, such as methylchloroform, currently have no acceptable and safe substitutes, whilst others, such as the CFCs, are sometimes used for purposes, such as most aerosol sprays, for which there are acceptable substitutes. We **recommend** that industry should be encouraged to restrict the use of gases (including chlorofluorocarbons) which may deplete stratospheric ozone to purposes for which no acceptable substitutes exist. Recognising the global dimension of the problem, we **recommend** that the Government should take the initiative through the European Community, the Organisation for Economic Co-operation and Development, and other international agencies, to encourage a worldwide policy to restrict the use of gases (including chlorofluorocarbons) which may deplete stratospheric ozone to essential purposes.

CARBON DIOXIDE AND CLIMATIC CHANGE

Carbon dioxide in the atmosphere

5.115 Man's activities both in burning fossil fuels and in deforestation, which have accelerated since the industrial revolution, have led to the release and consequent increase in concentration of carbon dioxide (CO_2) in the atmosphere. The possibility that changes in global climate will be brought about by the increase in atmospheric CO_2 was suggested almost half a century ago(279) but only relatively recently has the issue become one of concern and scientific controversy.

5.116 Carbon dioxide is only a trace gas in the atmosphere (0.03 per cent by volume), but it is the source of carbon that becomes fixed by green plants through the process of photosynthesis, thereby providing the basis of all plant and animal life. There are about 720 × 10^{15}g of carbon in the atmosphere in continuous exchange with carbon in other pools in the biota, the organic soil fractions and the oceans (Figure 5.7). The amount of carbon in the atmosphere

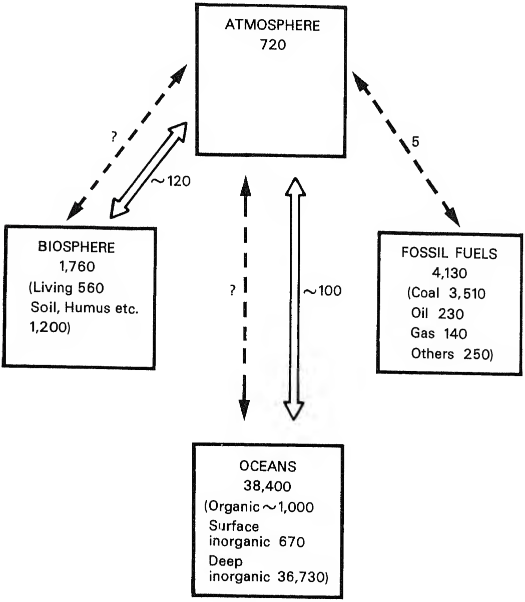

Figure 5.7
Global pools and annual fluxes of carbon
Figures are in 10^{15}g carbon. Solid arrows represent natural fluxes and hatched lines those due to man's activities.

Source: Reference (280)

is small compared with the other pools, particularly the oceans, where most of the carbon is in the form of dissolved CO_2. The surface layers of the ocean are well mixed and there is a relatively rapid exchange of CO_2 with the atmosphere. The much larger reservoir of deep ocean water is poorly mixed with the surface waters except in particular areas such as the polar regions. It is generally believed that the abyssal regions of the oceans have the capacity to absorb very much more CO_2 than at present, but the exchange of carbon between the surface waters and the deep ocean is extremely slow. There are many gaps in our understanding of air-sea interactions and of the behaviour of the oceanic pool of carbon. Any consideration of the effects of increasing atmospheric CO_2 concentrations must take into account interchange with carbon in other pools.

5.117 Carbon dioxide is fairly transparent to incoming solar radiation which falls on the earth and heats it. The warm earth radiates in turn, but at a longer wavelength than that of the incoming solar radiation. To this longer wavelength CO_2, unlike most major constituents of the atmosphere, is relatively opaque and consequently reflects back radiation that would otherwise be lost into space, thus causing an increase in the temperature of the earth and its atmosphere. Glass, like CO_2, is transparent to solar radiation but not to the longer wavelengths and this property enables its use to trap heat in greenhouses—hence, by analogy, the term 'greenhouse effect' applied to the expected consequences of an increase in the concentration of CO_2 in the atmosphere.

5.118 It is well established that the concentration of CO_2 in the atmosphere is increasing. Accurate measurements have only been made over the last 25 years but it is considered that at the start of the industrial revolution there was less than 300 parts per million (ppm). The longest daily record comes from the Mauna Loa Observatory (Hawaii)(281) where a steady rise in the annual average concentration from 316 ppm in 1959 to 338 ppm in 1980 is generally believed to reflect a global trend (Figure 5.8). There are both seasonal and spatial variations in atmospheric CO_2 concentration, but there can be no doubt that the upward trend is real. It should be noted, however, that there are also natural fluctuations: studies of air trapped in ice cores of known age have shown atmospheric concentrations varying between about 200 ppm and 300 ppm over the past 40,000 years(282).

5.119 The great increase in the burning of fossil fuels, which produces essentially CO_2 and water, since the advent of the industrial revolution is the primary cause of the increase in atmospheric CO_2 concentration. This CO_2 and that from the manufacture of cement is released directly to the atmosphere (Figure 5.9). It has been estimated that the annual amount of carbon released to the atmosphere increased from about 2.5×10^{15}g in 1960 to about 5.3×10^{15}g in 1980(283). A secondary cause, the significance of which is a matter of considerable uncertainty, is change in land use, especially the deforestation of the tropics which has reduced the accumulation of carbon through photosynthesis and increased its release to the atmosphere through decomposition of vegetation. On the other hand some other changes in land

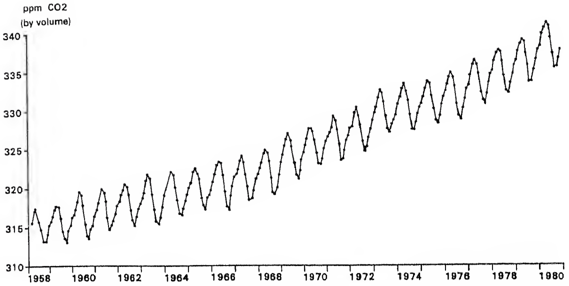

Figure 5.8
Monthly average carbon dioxide concentrations at Mauna Loa Observatory, Hawaii
Source: Reference (281)

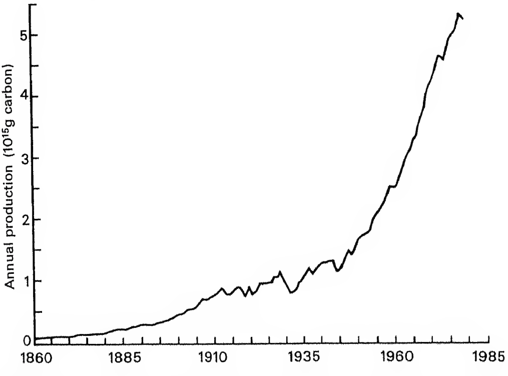

Figure 5.9
Annual world carbon dioxide production from fossil fuel combustion and cement manufacture
Source: Reference (283)

use, such as the introduction of intensive crop cultivation, may well have increased the rate at which CO_2 is photosynthetically removed from the air. Recent estimates suggest an annual release of about 2 × 10^{15}g of carbon to the atmosphere from vegetation(284)—considerably less than from fossil fuels. It can be calculated that little more than a half of the CO_2 being added to the atmosphere by man's activities remains there; most of the remainder is taken up by the ocean.

5.120 The rate at which atmospheric concentration of CO_2 is likely to rise has usually been expressed in terms of the year in which the CO_2 concentration reaches 600 ppm i.e. double that at the start of the industrial revolution. Three factors influence this: changes in land use; the rate of combustion of fossil fuel; and the proportion of the added CO_2 that remains airborne. It is thought that the changes in the first will not be a significant factor in the future. But over the last decade, as estimates of energy growth and fossil fuel use have declined and evidence for a larger take-up by the oceans has accumulated, the projected date for the doubling has receded. Recent estimates suggest some time around the third quarter of the next century(280, 285).

Effects of increased carbon dioxide concentrations

5.121 It is also agreed that the increase of CO_2, because of the greenhouse effect, will result in an increase in the temperature of the lower atmosphere and of the earth's surface. There is considerable uncertainty, however, about the magnitude of this temperature increase. The main research in this field has been by means of one- and three-dimensional models. One-dimensional models consider the redistribution of mass, heat and water vapour locally due to vertical movement only. This greatly simplifies the real situation and involves many important assumptions. The response of one-dimensional models to a doubling of CO_2 varies fairly widely according to the assumptions made. The three-dimensional models more completely represent the physical processes in the atmosphere, but they also include major assumptions, partly to reduce the computations and partly because the processes are insufficiently understood. The areas of greatest uncertainty concern the roles of the oceans, clouds, and particulates in the atmosphere from sources such as volcanoes and deserts. The results from recent models are in general agreement in indicating that a doubling of CO_2 will produce appreciable changes in climate with an increase of 2-3°C in mean global temperatures(280). Most, but not all, scientists in this field consider that such a figure represents the best estimate in the light of current knowledge. However, these results should not be considered as accurate estimations, but rather as predictions based on particular scenarios. It has been put to us that it will require extensive research over at least a decade before there can be confidence in the scenarios used in the models(260). At present the models are capable of providing reasonable estimates of globally averaged quantities.

5.122 Because the pattern of factors that determine climate is extremely complex and far from completely understood, it is proving very difficult to find convincing quantitative evidence that will relate the concentration of CO_2 in the atmosphere and climatic conditions. There is a background of natural fluctuations of the earth's surface temperature, of different periodicities, due to factors such as volcanic and solar activities. The global mean temperature increased about 0.5°C between 1885 and 1940, but then fell slightly, giving an increase of about 0.4°C over the last century(286). However, the temperature in the northern hemisphere actually decreased by about 0.5°C between 1940 and 1970(287), a time of rapid CO_2 increase.

5.123 However, CO_2 is not the only gas found in the atmosphere which has a greenhouse effect. Because of their physical properties many trace gases, including ozone, chlorofluorocarbons, methane and nitrous oxide, can have such an effect(288). Estimates of the scale of the effect of these 'minor components' of the greenhouse effect are far more uncertain than those due to CO_2. More information is needed on their rate of production from both anthropogenic and natural sources and on trends in their concentrations in the atmosphere. Unlike CO_2 many of these gases are chemically reactive in the atmosphere and our knowledge of their sinks and rates of removal is limited. Despite these uncertainties it has been suggested that a doubling in concentration of all these minor components would have an effect on the temperature of the Earth's surface about equal to that of a doubling of the CO_2 concentration(288).

5.124 Increased atmospheric CO_2 concentrations would have complex effects on climate. An average global temperature increase of 2-3°C (see paragraph 5.121) would cover wide regional variations and models are now being developed to indicate more detailed regional climatic change. Present results indicate that temperature differences between latitudes would decrease and, because of the greater land area, the temperature increase would be greater in the northern hemisphere. Greater than average warming would be expected in high latitudes and lower than average in the tropics; some areas might experience cooling.

5.125 The global pattern of rainfall would also be affected by increased CO_2 concentrations. Recent modelling studies(289) have suggested that the tropics would become generally wetter, that dry subtropical regions would become drier and increase in area towards higher latitudes, and that areas bordering the eastern coasts of continents would become wetter. Such changes in the hydrological cycle would be of greater direct importance for agriculture and commerce than either changes in temperature or atmospheric CO_2 concentration.

5.126 It is on the subject of sea level changes that some of the more alarmist predictions have been made. It has been suggested, for example, that the increase in atmospheric CO_2 could melt the marine west Antarctic ice sheet, rapidly raising the global sea level by several metres(290). Predictions have changed with the results of more recent modelling exercises and there is now an apparent consensus among glaciologists that any problem of this scale is long-term and unlikely to occur in the next century or two(260). It should be noted, however, that there are indications that the mean sea level has risen by about 12 cm over the past century(291) and that further changes of that magnitude could present problems at many places around the coasts of the United Kingdom particularly where the land itself is slowly sinking.

5.127 Climatic changes, such as those outlined in paragraphs 5.124 and 5.125, could also have far reaching biological effects, including changes in the distributions of plants and animals. Although such changes are unlikely to have direct effects on human health, some areas in the tropics are at present on the borderline of suitability for inhabitation by man and a temperature increase of only a few degrees, associated with high rainfall, could make them uninhabitable.

5.128 The growth and yield of crop plants would be affected, both directly and indirectly. It has been calculated(292) that the net effect of an increase in CO_2 concentration in the United Kingdom will be a decrease in yield of some crops, such as cereals and potatoes, and an increase in the yield of others, such as sugar beet, grass and coniferous forests. The position is complicated and the effects of agriculture will vary between crops and between regions.

5.129 The implications for the United Kingdom of temperature increases were considered in a 1980 Cabinet Office report(293). The general conclusion was that changes in the annual and seasonal average temperatures of 1–2°C would create no greater problems than are faced in years of extreme weather. Nevertheless, over a long period there would be substantial economic implications due to changed patterns of agriculture and commerce. Not all the effects would be detrimental. For example, for each 1°C mean annual temperature increase a reduction in energy demand of about 2 per cent was forecasted.

Conclusions

5.130 We can be certain that CO_2 concentrations in the atmosphere are increasing, we can be fairly confident that this will result in a warming of the earth's atmosphere, but we can be less confident about the magnitude and distribution of the warming and of other effects. However, the social and economic consequences of substantial change in climatic (especially rainfall) patterns, if not recognised and planned for in time, could be very great indeed as could the measures that would have to be taken internationally to reduce CO_2 emissions if the greenhouse effect provided to be significant. Research must therefore continue internationally both to formulate models and to seek historical and other evidence with which to validate or disprove them, taking into account, in an integrated fashion, the effects of all gases and particulates which contribute to the greenhouse effect. While recognising that this may well be a field of research in which the work cannot be greatly accelerated by increasing effort, we **recommend** that all necessary steps should be taken to ensure that there is the best chance of an early resolution of the uncertainties surrounding the effects of increasing concentrations of carbon dioxide in the atmosphere.

5.131 If research strengthens the predictions that increasing atmospheric CO_2 concentrations will have appreciable effects on climate, then we will need to have considerably more details of effects on a local level. So far as agriculture in the United Kingdom is concerned, predictions of global, or even regional, mean temperature changes are of limited value; what are needed are data on, for example, early frosts and extremes of temperature.

5.132 The problem of increasing atmospheric CO_2 is a global one and any action by the United Kingdom alone would be ineffective. It is notable, however, that by far the greatest contribution to atmospheric CO_2 comes from the burning of coal (Figure 5.7) and is likely to remain so for the foreseeable future. Over 60 per cent of the world reserves of coal are in Western Europe, the United States and the USSR (Figure 5.10). In principle, therefore, the governments of a relatively small number of countries (but representing perhaps a little more than 20 per cent of the world's population) hold the key to international action to reduce anthropogenic CO_2 emissions, should that ever be considered necessary. It is noteworthy that it is the grain growing regions of these very countries whose agricultural productivity is likely to be most affected by the changing pattern of rainfall.

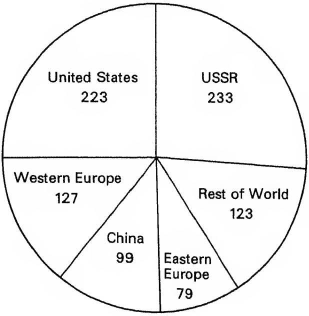

Figure 5.10
World coal reserves
Figures in 10^9 tonnes.
Source: Reference (294)

ATMOSPHERE AND ENERGY

5.133 Nearly all the issues considered in this chapter bring out the close relationship between atmospheric pollution and strategies for energy production and conservation. Most of the world's energy comes from the burning of fossil fuels, which is the largest single cause of atmospheric pollution. Two long-term policy aims therefore run in parallel—to conserve a wasting asset and to reduce the pollution which results from its use. Both provide an impetus for seeking alternative energy sources.

5.134 The Sixth Report of the Commission(4) contained the statement 'Our charge is the protection of the environment and we would favour an energy strategy that offers the prospect of least environmental harm'. We endorse that statement entirely. We believe that the United Kingdom should be ready to start switching energy sources if the results of research suggest an appreciable risk of the more pessimistic predictions discussed in this chapter becoming true. As we have indicated, such a position may be a long way off. But the nature of the problems, and their possible consequences, are such as to make it wholly imprudent to defer serious contingency planning. We **recommend** that an appraisal of alternative energy scenarios, in preparation for a possible progressive shift away from fossil fuels, should be given the highest priority and that the Government should regularly inform Parliament and the public of its current assessment of future energy requirements and their sources.

5.135 Fossil fuels account for some 90 per cent of worldwide commercial energy consumption and an even higher percentage of energy used in the United Kingdom (Figure 5.11). Forecasts of world commercial energy demand for the year 2000 (Figure 5.12) suggest that the present 10 per cent derived from non-fossil sources may at the most double. For immediate practical purposes, these sources can be divided into nuclear fission (see paragraphs 5.137–5.139) and a variety of sources often grouped under the label of 'renewable'. In addition there is considerable interest in new sources of energy which may have important long-term potential but are not yet capable of practical exploitation. In particular, thermonuclear fusion is the subject of several major research and development programmes in different parts of the world; Member States of the European Community have joined forces to build the experimental installation at Culham, in Oxfordshire, known as JET (Joint European Torus). Provided that adequate resources are committed to it, as recommended in the Sixth Report(4), and that this is done on an international scale with the current high levels of collaboration, thermonuclear fusion might become available as a source of energy within 50 years; that is, before carbon dioxide levels will have doubled (see paragraph 5.120).

5.136 The many sources of 'renewable' energy* include the sun (solar energy), the oceans (wave energy), rivers (hydro-energy), the earth (geothermal energy) and living organisms (biomass). Renewable energy sources were touched upon in the Sixth Report, which drew attention to the enormous discrepancy between the United Kingdom Atomic Energy Authority's annual expenditure on nuclear fission research and development and government-sponsored research into alternative sources—respectively about £80 million and less than £2 million per annum in 1976†—and to the fact that the latter was substantially less than that in most other industrialised countries. We note

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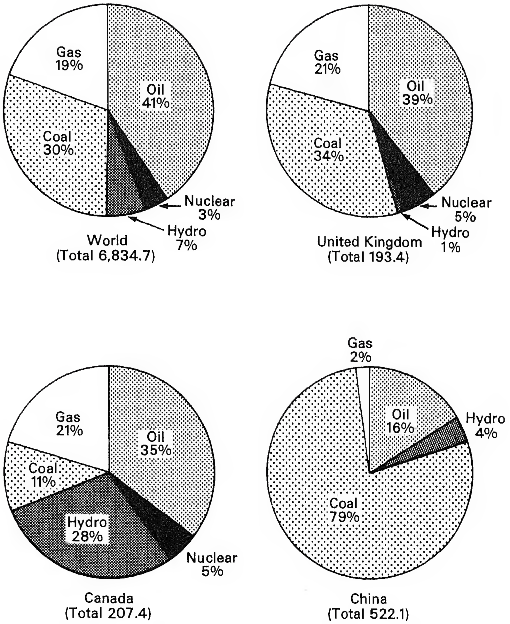
*We use this phrase to mean sources of energy which, although theoretically limited, can be expected to remain in abundant supply in the foreseeable future.

†The large difference between these two figures was partly because much research into alternative sources had not yet reached the expensive development stage.



World
(Total 6,834.7)

United Kingdom
(Total 193.4)

Canada
(Total 207.4)

China
(Total 522.1)

Figure 5.11
Energy consumption in the world and selected countries, 1982
Total figures are in 10^6 tonnes oil equivalent.
Source: Reference (295)

that, in the financial year 1983/4, the Government expects to spend some £14 million on new and renewable sources of energy(297) and over £103 million(298) on promotion of and research into energy conservation. We are not competent to judge how far, in absolute terms, these sums are adequate for the tasks in hand, although the contrast between them and expenditure on nuclear fission remains.

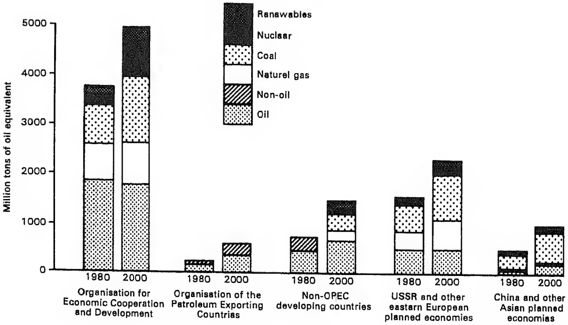


Figure 5.12
Total primary energy consumption 1980 and forecasts for 2000
Source: Reference (296)

5.137 The other main alternative to fossil fuels is nuclear fission. Despite the growth of nuclear power over the past two decades it still makes a very small contribution to meeting the world's energy demand (Figure 5.13). The environmental problems of nuclear power, particularly in relation to the disposal of spent waste, were discussed in the Sixth Report(4). At that time (1976) it was envisaged that both primary energy consumption and the share of it provided by nuclear power in the United Kingdom would increase at a far greater rate than has in fact occurred. Nevertheless we consider that the Report's conclusions and recommendations have fully stood the test of time and in some respects have even greater force today.

5.138 We respect the fears that many people continue to express about certain aspects of the nuclear power programme. The safeguards recommended in the Sixth Report have been largely accepted by successive United Kingdom Governments. The United Kingdom nuclear industry has devoted considerable effort and expertise to the reduction of risk and the safety record of British nuclear power stations is good. As the reduction of atmospheric pollution may in the future be seen as imperative we therefore believe that the

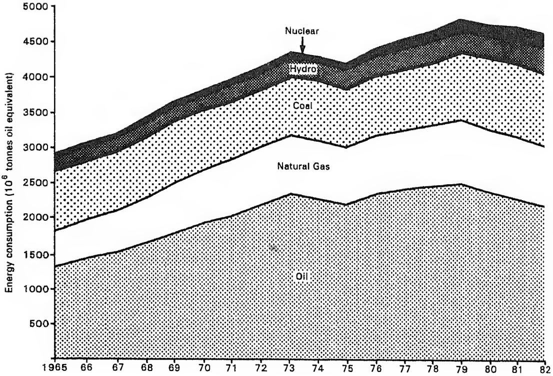


Figure 5.13
Primary energy consumption in the non-communist world, 1965–1982
Source: Reference (295)

United Kingdom should retain a wide range of options for achieving that reduction. Until the United Kingdom has a secure and environmentally attractive alternative, it would be wrong to discard the experience and expertise gained from several decades of nuclear power development. We would therefore support a modest increase in nuclear power capacity as part of a strategy for reducing dependence on fossil fuels as a primary energy source and for reducing the polluting effects of their combustion.

5.139 In the future, a rapid extension of nuclear capacity may come to be regarded as the best method of reducing atmospheric pollution from energy production. However, we repeat that such a strategy should not be supported in the United Kingdom unless there is an unqualified commitment to the principles set out in the Sixth Report. Of these, we would stress in particular the need to maintain the nuclear industry's safety record (paragraphs 277–292 in the Sixth Report), the development of satisfactory waste disposal policies (paragraphs 427–435), and the availability of information to enable all relevant issues to be debated and resolved fully and publicly (paragraphs 521–524). Furthermore, in supporting the principles set out in the Sixth Report, we would expect that as an accompaniment to such a policy the Government would continue its efforts, through national and international action, to minimise the risks of nuclear weapons proliferation (paragraphs 326–329) and the diversion of plutonium for non-peaceful uses (paragraphs 316–325).

5.140 Since so many of the important environmental issues of the remaining years of this century are closely bound up with energy policy, the Government must have at its disposal broadly-based advice of the highest quality. As our predecessors said in the Sixth Report, we are not an energy commission; and whilst we ourselves would not hesitate to embark again on an assessment of possible scenarios, as was done in that report, if we felt that this task was being seriously neglected, we would prefer to think that by now the Government is fully seized of the importance of the task and the need for proper integration of environmental and energy policy.

5.141 Unfortunately, recent events have left us less than confident that this is so. As we have noted already (paragraph 1.16), the Commission on Energy and the Environment (CENE)—set up in partial response to a recommendation in the Royal Commission's Sixth Report—has been 'in abeyance' since the publication of its only major report(129). In its White Paper responding to the report(131), the Government said:

> 'The Report on coal and the environment complements earlier reports by the Royal Commission on Environmental Pollution on nuclear power and the environment (their Sixth Report) and on oil production and the marine environment (their Eighth Report). Taken together these reports represent a major source of advice on current energy and environmental issues. They have each led to specific action to deal with the problems identified as well as initiating a lively and rewarding debate between government, the supply industries, and the public, and this will continue.'

5.142 Whilst we are pleased to note the Government's reaffirmation of the importance it attaches to the advice contained in successive reports from this Commission and CENE (to which must now be added the recommendations in our Ninth Report relating to the use of lead in petrol), we must stress that we do not regard this as a satisfactory substitute for a *standing,* independent source of advice on energy strategy and its environmental consequences. The recommendation in the Sixth Report (itself an endorsement of ideas already current) was for 'a high-level independent body to provide advice on energy strategy, taking account of economic, social, technical and environmental considerations'. This implied wider terms of reference than were, in the event, given to CENE, which were 'to advise on the interaction between energy policy and the environment'. The reason for this was that CENE was intended to work in tandem with the Energy Commission—a body which was abolished in 1979.

5.143 We do not consider that our past reports and that of CENE can be regarded as a comprehensive assembly of advice covering all the main energy and environmental issues. Quite apart from any effects of the passage of time on, for example, the prospects for fusion power, certain major energy sectors (for example, natural gas and renewable sources) remain to be considered in depth; there are also important general issues which demand proper examination. One such issue would have been the subject of CENE's second study—an evaluation of the risks inherent in a supply-orientated policy compared with a policy which emphasised efficiency in energy use, including an examination of the environmental impacts of energy conservation.

5.144 These and other points were put forward in a debate initiated by one of our members in the House of Lords on 22 February 1983(299). The Government spokesman gave a categorical assurance that 'in abeyance' meant what it said and that 'the point has always been made that if there was a pressing need then the Commission would be reactivated'. We are more than satisfied that the 'pressing need' exists. We accordingly **recommend** that the Commission on Energy and the Environment should be reconstituted, but with wider terms of reference in accordance with the original recommendation in the Royal Commission's Sixth Report. We believe that no existing body, including ourselves, or interdepartmental machinery within Government can carry out these tasks adequately.

CHAPTER VI

FUTURE POLICY FOR POLLUTION CONTROL

Change is inevitable. In a progressive country change is constant.

Disraeli, 29 October 1867, Edinburgh

Introduction

6.1 In this chapter we seek to draw together the main themes of the Report, relating them to changes in the economic climate and to the next stages of the Commission's work. We conclude with a statement of the general principles which we see as an appropriate guide for pollution control policy in the future. A list of our more important conclusions and all our recommendations is in Chapter VII.

Progress and change

6.2 There is ample evidence, from the data reviewed in this report and from earlier reports of the Commission, that during the last 20 years there has been considerable progress in tackling the grosser forms of pollution, as typified by smoky towns or dirty rivers. Such problems have hitherto been perceived as relatively localised, since the sources of the pollution and its effects can be fairly simply related to each other. The resolution of the remaining gross problems of this kind (such as the state of the Mersey—see paragraph 4.15) is largely a matter of finding the necessary resources rather than of lack of technical understanding. However, in one area—agriculture—we cannot discern clear evidence of the general trend to reduction of pollution. Incidents of water pollution caused by farm wastes have been increasing steadily(300) and straw burning has been causing continued problems (see paragraphs 2.7–2.11).

6.3 The pollution concerns that have become apparent over recent years differ in two significant respects from those that we have so far mentioned: their effects are widespread rather than local and often transgress national boundaries, and their potential for damage, though possibly very great, is uncertain and not easy to evaluate. It is also now recognised that some of the problems hitherto regarded as purely local may have a far wider significance: for example, air pollution from traffic in towns may contribute to the problem of acid deposition and to other long-term atmospheric problems; and industrial discharges or emissions of many substances—not necessarily 'black list' ones (paragraph 1.12)—may need to be controlled regionally or globally rather than merely locally. (Our Ninth Report provides a further example of this type of problem.)

6.4 The recognition of these problems has been due in large measure to imaginative thinking by scientists and others calling on new resources for the detection and estimation of compounds present at very low concentrations and on techniques such as mathematical modelling for experimentation. Another factor has been the widespread use of relatively new substances, such as chlorofluorocarbons (see paragraph 5.97 *et seq.*). Moreover education, the media and pressure groups have heightened public awareness and concern for matters of pollution and have generated political pressure for improvement(301). We thus face questions that are more complex and more far-reaching than those of the past and a public that is more sensitive to problems of pollution and more committed to having them dealt with.

6.5 An inevitable consequence of the geographically far-reaching effects of many persistent pollutants is the blurring of distinctions, which may have been helpful in the past, between the problems afflicting different localities, notably between rural and urban locations, although 'hot spots' may remain in certain areas. The easy movement of persons and materials (through, for example, mass-produced food and large-scale water distribution systems) may also have helped to smooth out the major differences, and those that remain are likely to be outweighed by other factors such as housing or diet.

6.6 Perhaps even more significant is the recognition that pollution is but one thread in the tangled web of interactions that is modern society and one which cannot be neatly pulled out, leaving the remainder of the pattern undisturbed. Thus, for example, we attach great importance to the interactions of energy supply and pollution control strategies. Substantial further progress in control of pollution cannot be effective and efficient unless environmental problems are considered in good time and in an appropriately wide social, economic, political and technological context.

6.7 The importance of taking environmental factors into account is now considered seriously by most sectors of industry. We welcome the recent policy statement by the Confederation of British Industry(49), which concludes that environmental pressures should be recognised as 'helpful stimuli rather than obstructions, (which) could uncover possibilities hitherto not recognised as beneficial'. Even where pressures prove to be a constraint they may provide competitive opportunities. The need to conform to environmental standards is one element of the market requirement and thus offers opportunities for gaining a lead through technological innovation.

6.8 There is a growing acceptance by industry and regulatory authorities of the need to share information with the public, but we have suggested in Chapter II that this trend needs to be reinforced. Many of the areas where there is public concern (for example, radioactive waste, transport of hazardous waste, or pesticides) are those where there is least openness. These do not necessarily coincide with the areas which we believe may pose the greatest threat to the environment.

6.9 Since society will always have wastes to dispose of, a position will never be reached where all problems have been eliminated: industrial innovation will pose new challenges and the perception and evaluation of the risk of damage will continue to change. Alongside this constant change there must be continuous progress in abating pollution. Cycles of complacency alternating with panic are the least effective approach to environmental improvement, and carry economic penalties.

What are the main problems now?

6.10 Our study has shown that there remain a number of problems in the air pollution field, covering a wide spectrum. Diesel smoke is an example of a continuing, and probably growing, localised problem which ought to be capable of solution within a relatively short time (paragraph 5.71). Photochemical smog is now recognised to be a more widespread problem than originally thought (paragraphs 5.72–5.77). The phenomenon of acid deposition (less accurately known as 'acid rain'), which probably involves a number of different processes, is widespread throughout the northern temperate regions. Neither its effects nor the most efficient methods of mitigating them (or reducing the phenomenon at source) are properly understood. It is the most vigorously debated international pollution problem today (paragraph 5.78 *et seq.*).

6.11 A relatively new feature, of major significance, is the number of long term global problems. Considerable uncertainty surrounds many of the scenarios (for example, those relating to increased carbon dioxide levels or to ozone depletion), but some of the predictions are extremely grave. Whilst the extent of current uncertainty is so great that drastic action cannot be justified at present, we believe that contingency planning and development are appropriate (for example, research into and development of a variety of energy sources), whilst the avoidance of inessential uses (or conservation, in the case of energy) may increase the time before deleterious changes take effect and provide in the meantime an opportunity for technical innovation (paragraph 5.97 *et seq.*).

6.12 At a more local level, we are also beginning to see the explosion of what might be called environmental 'time bombs', some of which have been brought forward by recent trends. Many of them, for example asbestos, can be said to be a legacy of the past, where we have learned the lesson and are unlikely to repeat the mistakes. In other cases (such as those of contaminated land or decommissioned industrial sites) the damage may also have been done but the full measure of the problem has not been determined nor has effective remedial action been devised. In others we can see a hazard from continued accumulation of pollutants which needs to be brought to a halt (as we recommend for lead in our Ninth Report(7)), particularly when pollution is irreversible or when later clean-up or retrofitting is likely to be disproportionately expensive or simply not practicable.

6.13 An important feature of the type of long-term environmental protection policy which we recommend in this Report is that it should guard against creating situations which, though they may initially appear innocuous, have the potential for erupting disastrously—in other words, it should ensure that no new 'time bombs' are set. An area which in our view needs very careful assessment is the potential of newer industries, such as electronics and bioengineering, for causing novel forms of pollution, particularly those involving discharges of organic compounds in trace quantities. In view of the encouragement which such new technology receives from governments all over the world, in many cases involving 'green field' developments, we believe that analysis of its polluting effects, and their abatement or preferably elimination at source, is a matter of some urgency, particularly since many of the smaller pioneering firms may lack the experience and technology to cope with the wastes they generate([302]).

6.14 For example, we note that a study for the US Environmental Protection Agency has indicated a range of potential pollution problems associated with the manufacture, use and disposal of photovoltaic sunlight-to-electricity equipment, particularly in regions where large-scale solar power plants become commonplace([303]). There have also been widespread reports of pollution by toxic chemicals, some of them of an 'exotic' nature, from the 'Silicon Valley' manufacturers in California([304]). In this country we note that a study for the Department of the Environment of the new industrial belt to the south west of London([305]) has emphasised the need for vigilance on the part of pollution control authorities when dealing with new developments, particularly in the electronics industry. We therefore **recommend** that the Department of the Environment should give high priority to further research on the potentially polluting effects of electronics, bioengineering and other technologically advanced industries. We also consider that a degree of caution may be necessary in promoting new developments in Enterprise Zones, where planning controls have to a large extent been relaxed. Our enquiries have indicated that local authorities are fully cognisant of the long-term dangers. We **recommend** that local and other statutory authorities should continue to apply the same pollution control standards in Enterprise Zones as elsewhere.

6.15 Many of the problems from the past arise as a result of the pollution of land—from landfill waste disposal (or uncontrolled tipping in former times) and in sites of former industrial activities. We have seen some dramatic instances of the latter in the north of England. From preliminary evidence on these matters which we assembled in 1982, we concluded that there were issues which, although highly relevant to this Report, required more detailed study over a longer period. We were also aware of the recent report by the House of Lords Select Committee on Science and Technology on hazardous waste disposal([81]) and it seemed sensible to wait for the issues to clarify before embarking on a further review. We have therefore decided that our next study should be concerned with pollution by wastes, including the problem of land contamination; we are now considering the particular areas for investigation in what is potentially a very broad subject.

6.16 We have also given much thought to the question whether the Commission should study noise, and we did at one time favour this as the subject for our next major investigation. It is over 20 years since the Wilson Committee (306) reported on noise and it is a matter of widespread public concern (paragraph 2.5). Furthermore the demise of the Noise Advisory Council (paragraph 3.41) has left a gap in the arrangements for monitoring and evaluating official policies across the board. However, a study of noise presents problems of a nature and scale unlike those of most pollutants. Outside the workplace, noise is more a social nuisance than a source of harm to health or damage to the environment. The incidents that cause people concern have virtually no impact on the natural environment, and indeed persons differ in their attitudes to for example the noise from pop concerts or motor cycles. Noise, it has been said, is the sound that somebody else makes. In addition, there are considerable problems relating to the objective measurement of noise. Whilst recognising the high priority given by many people to noise as a pollutant (paragraph 2.5) and the need for a comprehensive study, which has been impressed on us by a number of bodies, we have not been convinced that at this stage we would be well placed to undertake such a study ourselves. We also find it difficult to perceive how the study would lead to practical recommendations. However, recognising that this may be because we have not got the measure of the problem we propose to continue to devote a portion of our time to the problems of environmental noise in parallel with the study on pollution by wastes, which will take up the major part of our time.

Pollution control in relation to the current economic climate

6.17 The economic context in which measures to combat environmental pollution have now to be considered is entirely different from that which applied when the Commission was established. Investment in pollution abatement will often show an economic gain to the polluter in the longer run. Recovered waste may turn out to be a useful raw material, or the technology of pollution abatement may itself prove to be saleable (and exportable). Such investment is however less likely to be undertaken, in the absence of outside pressure, when real interest rates are high and profits depressed(307).

6.18 One effect of economic recession may be to make people more willing to tolerate existing levels of pollution if the alternative is seen to be a further decline in local employment. We have, however, already noted (paragraphs 1.20 and 1.21) the evidence from recent opinion polls of continuing concern about pollution. Although their findings may not be representative of opinion in the areas worst affected by recession, we believe that the public is, in general, not prepared to see a lowering of standards of control and that emitters and regulatory authorities cannot afford to be complacent(302).

6.19 It is, in any case, a mistake to think that a lowering of standards will necessarily help to preserve employment or encourage enterprise. Such an approach is short-sighted and risks setting new 'time bombs' (paragraph 6.12).

Any industry treated in this way is effectively being subsidised by environmental neglect. Like any subsidised industry it will be vulnerable to the withdrawal of its subsidy, which may happen as a result of local, national or international pressure to improve pollution control. The cost of removing the subsidy may well be greater than the original benefit.

6.20 The avoidance of future loss has present worth. Environmental pollution may often be a 'negative investment', in that problems are created that will significantly add to costs in future years. Retrofitting of pollution control equipment and waste clearance operations are almost invariably more expensive than incorporation of the equipment in the original plant and sustained application of adequate waste management measures. We are therefore concerned that one effect of the present recession and the consequential squeeze on regulatory authorities' budgets may be a reduced level of enforcement, thereby permitting practices whose eventual correction will bring economic penalties. Our recommendations in Chapter II on the need to remove unnecessary secrecy and to strengthen local authorities' powers would go some way towards ensuring that problems are identified and nipped in the bud.

6.21 Although instances have been cited to us where environmental regulation has allegedly threatened the viability of particular firms, there appears to be little empirical evidence of plant closures directly attributable to environmental controls(308), and the consensus of a number of studies, mainly in the United States (309), is that the overall effects of pollution control on inflation and employment are small and uncertain. The Trades Union Congress, in its evidence to us, has suggested that these studies may tend to underestimate the positive economic effects of environmental legislation. We believe these issues may merit further research.

'Pollution prevention pays'

6.22 Although environmental improvement is generally thought of as adding to costs, recent studies under the auspices of the United Nations Environment Programme(310) have demonstrated an increasing awareness of the potential economic benefits that can flow from pressures to reduce pollution. For example, pollutants represent waste and often irretrievable dispersion of raw materials and energy, the avoidance of which could be of immediate economic benefit. Moreover, a reduction in pollution can be expected to result in an improvement in people's physical and mental health and this should generate a positive impetus to the economy both nationally and locally. One local effect is that environmental improvement encourages both the development of modern, low-polluting industries and the recruitment and retention of staff to work in them. A major problem in reviving older inner-city areas is the legacy of accumulated pollution and dereliction from earlier times.

6.23 The national cost (measured as reduction of gross domestic product) of pollution control will be less than that calculated from the environmental expenditure of the private and public sectors, because a proportion of that expenditure will be on domestically manufactured pollution abatement equipment(311). Any pollution abatement equipment exported will make an additional contribution to gross domestic product and thus it is in the national interest to have a successful environmental protection industry.

6.24 We believe that high environmental standards at home will, in general, help to sustain an internationally competitive pollution abatement industry. A country that can maintain a position in the van of pollution control will have considerable opportunities for the export of appropriate technology and equipment, provided other countries follow suit with similar abatement policies. In contrast, a country that is reluctant to control pollution and becomes something of a laggard in this respect will almost certainly pay the additional penalty, when it eventually conforms, of having to import much of the technology. We had these considerations very much in mind when we recommended, in our Ninth Report(7), that the United Kingdom should give a lead to the rest of Europe in phasing out the use of lead in petrol.

6.25 Support for the development and operation of pollution control technology by various financial incentives or investment grants is not uncommon in the United States, and we note that European Community environmental policy contains the very modest beginnings of a similar approach. The current (1983) budget, as approved by the European Parliament(312), envisages expenditure of 1·5 million ECU (£0·85m) on aid for the development of 'clean technologies', which the European Commission has defined as those which 'cause little or no pollution and are more economical of natural resources, in particular raw materials'. Proposals to put this and other components of the European Community's 'Environment Fund' on to a regular footing, although supported by the Parliament, are a matter of continuing discussion in the Council of Ministers(313).

6.26 In parallel to these European Community developments, we were pleased to note the recent launching in this country of a Pollution Abatement Technology Award Scheme—an annual award for technological innovation in pollution abatement promoted by the Department of the Environment, the Confederation of British Industry, the ERAS Foundation and the Royal Society of Arts. In launching the scheme, the Hon William Waldegrave, MP, Parliamentary Under Secretary of State for the Environment, underlined the points we have made:

> 'If you look at the countries which have the strongest position in the growing international trade in technology control equipment, they are the countries, such as Japan and the USA, which have the toughest pollution

> laws at home. Our trade, which is growing and is valuable, tends to be with countries at the earliest stage of industrialisation. What we risk is that, as these countries develop, so they will tighten regulations and shift their trade to those whose home markets have long been based on tight regulations . . . . If British industry in one aspect were to make Britain a laggard rather than a leader in environmental standards, and hence in the development of techniques to meet those higher standards here at home, British industry in another aspect will inevitably lose out.'(314)

6.27 These comments should be seen in the light of some recent observations by Lord Sherfield:

> 'Commercial disadvantage is a powerful obstacle to environmental protection. What a nation can afford on its own is less than it can afford when its competitors adopt the same measures to restrict pollution simultaneously. Initiatives by the European Community and other international bodies in the field of environmental protection should therefore be welcomed and supported. The cooperative approach can surmount many commercial hindrances to good environmental practice.'(63)

As we have indicated, it is most important that the international approach is backed up by a positive stimulus to the domestic pollution control industry. We therefore endorse the conclusions in this context of the House of Lords Select Committee on the European Communities, in its report on the polluter pays principle(47), and **recommend** that the Government should undertake a study of the operation of subsidies for pollution control equipment and for clean technology in other Member States and should evaluate the consequences of the incorporation of similar arrangements in United Kingdom environmental policy.

6.28 A recent German study (315) has argued that pollution control policies may increase economic differences between regions, because polluting industries tend to be located in depressed areas and have to obtain their abatement equipment from the structurally more advanced wealthier regions. Therefore the regional impact of any scheme of subsidy for the United Kingdom would have to be carefully considered.

6.29 The stimulus to technological innovation will not be strong unless there is confidence that environmental improvements, once prescribed, will be pressed through, even during economic depressions. From both the environmental and the economic viewpoints pollution control must not be a cyclical activity, reserved for periods of economic expansion. We are glad to note that the European Community's Third Action Programme (see paragraph 3.12) emphasises the principle of continuity. Uncertainty is a deterrent to investment. As we have already indicated in our Ninth Report, in connection with the introduction of less polluting forms of motor vehicle technology, a steadfast policy of environmental improvement with measures announced in good time will contribute to a more efficient capital investment programme and stand the best chance of creating opportunities for combining environmental improvements with economic benefits to the industry itself. Similar principles apply to the phasing out of other practices—such as straw burning (see paragraphs 2.7–2.11)—which have adverse environmental but significant economic implications.

Framework and guiding principles for policy

6.30 In preparing this Report we have reviewed a wide range of pollution problems. The state of knowledge of the risks of damage varies widely, yet it is not always, or indeed often, possible to delay any response until there is scientific certainty (paragraphs 2.1–2.2 and 2.26–2.32). Faced with inconclusive evidence, the scientist is trained to respond with caution. However, evidence that is not conclusive when judged by the conventions adopted in scientific research may yet be a reasonable cause for concern to those who have to act on it outside the laboratory. The politician or manager who must decide what action to take *now* cannot wait for the rigorous proof that is properly demanded by a referee for a scientific journal. For those responsible for the well-being of the public and the protection of the environment there will sometimes be a difference between what can be believed with confidence and what in the absence of certainty it is prudent to assume. The manager must determine whether the perceived risk of damage justifies the cost of its alleviation: if it does, then a policy for the abatement of the pollution must be instituted.

6.31 Once it is considered that the time for the transition from evidence gathering to policy decisions (paragraphs 2.1 and 2.2) may have been reached, then a cost-effective policy for pollution abatement should incorporate two guiding concepts:—

(a) *Best Practicable Environmental Option* (BPEO):
the optimal allocation of the waste spatially; the use of different sectors of the environment to minimise damage overall.

(b) *Best Environmental Timetable* (BET):
the optimum timetable for the allocation of resources to pollution abatement.

6.32 The first of these has been discussed in Chapter III (paragraphs 3.27–3.30) and, as we mentioned at the outset (see paragraph 1.23), it is a theme which runs throughout the Report. In our next study (paragraph 6.15) we hope to explore the application of BPEO further. We have stressed the advantages of preventive, or anticipatory, action throughout this Report: as we have said in paragraph 6.9, we shall not, in the foreseeable future, eliminate all potential for pollution nor succeed in fully restoring the damage that has already been done. We therefore need a system that ensures that there is continual pressure for improved environmental quality, since the principle of steady, planned improvement is fundamental. The key features of BET, therefore, are anticipation and continuity. In so far as, through steadfast application of the principles, the future can be made more certain, costs will be reduced.

6.33 Many of the problems we have considered are facets of larger systems. Under BPEO a pollutant may be transferred from one part of the system to another: this should result in a reduction of the adverse effects, but these can seldom be totally eliminated and if action is excessive in one direction, then the effects may be substantial. This principle is stressed in the European Community's Third Action Programme (see paragraph 3.12).

6.34 In the course of our review we have come across many instances where adverse effects in one part of a system have resulted from measures for environmental protection elsewhere. These range from the local complaints about the noise from bottle banks—themselves designed to reduce litter and conserve raw materials (and hence energy)—to the global effects on climate that may arise from the build-up of carbon dioxide, heightened by the continued reliance on fossil fuels for energy to obviate the need for a large nuclear programme. Other examples include indoor pollution aggravated by the reduction of ventilation to conserve energy, an increase in transfrontier pollution following the adoption of high chimneys to reduce local pollution, and the production of more sewage sludge following action to improve river quality.

6.35 We believe that most of the present and future problems in environmental pollution will be of this cross-media type and will therefore demand a broad consideration, for which BPEO provides the correct framework. From this stems a need for pollution control authorities to have broad areas of responsibility and appropriate powers of enforcement, which go further than merely being able to act after the event.

6.36 We conclude that we need a more consistent and synoptic approach to pollution control in this country. Water authorities and central government inspectorates form a fragmented and insufficiently-coordinated pattern. The Commission's 'HMPI' concept (paragraph 3.31) has not gained acceptance, but there remains a need for proper coordination between authorities and a common approach which takes BPEO seriously. The Government's acceptance of the BPEO principle is therefore a major step in the right direction.

6.37 We hope and expect that technological innovation and industrial development will continue. Environmental policy must march in step with this progress (paragraph 6.9); it should be based on the anticipation of problems and should ensure that continuous headway is made towards their solution. Properly implemented, such a policy will stop cumulative pollution getting worse and will help to bring about a situation in which prevention of new pollution rather than cure is the accepted practice. These features have been emphasised in the European Community action programmes, and anticipation is a key characteristic (the *Vorsorgeprinzip*) of the approach of the Federal German Republic to pollution control. We also note that in the

Netherlands steps are currently being taken to integrate environmental protection in all aspects of public policy; these include proposals for a consolidated environment budget and the drawing up of indicative five year plans for various environmental sectors.

6.38 The formulation of pollution abatement policies needs to take increasing account of international factors. Many pollutants cross national boundaries and their control thus depends on various forms of international co-operation, which in the case of members of the European Community is now taking the form of trans-national legislation. The policy decisions reached at international meetings are influenced by political and commercial considerations, as well as by purely environmental arguments. Through these mechanisms, policies in one country may be influenced by public opinion in another.

6.39 Against this national and international background any policy based on expediency is bound to be buffeted in this direction and that; industry will therefore find itself faced with sudden decisions and with short timescales for the implementation of control measures. In the absence of a coherent and well articulated national policy for pollution abatement, decisions will become responses to national special interest groups or to increasingly frequent international pressures.

6.40 Much greater consistency is likely to be achieved if a Best Environmental Timetable is agreed and followed. The timetable will enable industry to take pollution abatement requirements into account in their forward planning: total costs will consequently often be reduced and technological advances achieved (paragraphs 6.17–6.21 and 6.29). As the Confederation of British Industry has stated, 'Environmental protection makes sense—as many companies have found to their gain—and provision for it needs always to be included in corporate plans'(49). We would, however, stress that provision can be made only if the required programme has been established. For instance, prolonged uncertainty over the implementation of Part II of the Control of Pollution Act 1974 (see paragraph 4.24 *et seq.*) has created difficulties for companies in the UK petroleum industry when deciding whether or not to invest in new pollution control equipment at coastal refineries. It has also led to fears that the delay will have made it harder for the United Kingdom to argue against proposals by other members of the European Community or the Paris Commission for uniform emission standards.

6.41 The concept of BET was already behind the recommendations in our Ninth Report for a phased programme for the elimination of lead from petrol and its reduction elsewhere, for example in paint. We have adopted it in this report in our recommendations on straw burning (paragraph 2.11) and on sulphur emissions (paragraph 5.96). The Clean Air Act 1956 and various European Community directives also have this feature of phased but continuous progress.

6.42 The BET for a particular pollution abatement programme needs to be precise and may well extend beyond one Parliament. We have referred already to the fate of Part II of the Control of Pollution Act, whose implementation has depended on commencement orders and the introduction of subordinate legislation (paragraph 3.50). We understand that there are precedents in existing UK statutes, as there are in European Community directives, for legislation which comes into force at fixed times in the future. If in the meantime additional knowledge indicates that some major change is necessary, Parliament is not inhibited from legislating further. In practice the agreed programme will proceed unless positive steps are taken to modify it, rather than, as with various provisions of the Control of Pollution Act, grind to a halt in the absence of additional statutory action.

6.43 As with all aspects of national policy involving investment, much is to be gained by consistency (see paragraph 6.40) and, at an early stage, by contingency planning and development. We do not, however, envisage that all, or even the majority of, abatement programmes will require to be backed by specific legislation.

6.44 Indeed, some potential problems are of such a long-term nature that it is not possible at this stage to draw up a specific abatement programme. As the recent report by the Carbon Dioxide Assessment Committee of the US National Research Council has said:

> 'There is a broad class of problems that have no "solution" in the sense of an agreed course of action that would be expected to make the problem go away. These problems can also be so important that they should not be avoided or ignored until the fog lifts. We simply must learn to deal more effectively with their twists and turns as they unfold. We require sensible regular progress to anticipate what these developments might be with a balanced diversity of approaches. The payoff is that we will have had the chance to consider alternative courses of action with some degree of calm before we may be forced to choose among them in urgency or have them forced on us when other—perhaps better—options have been lost.'

We feel that this statement underlines graphically the need for a dynamic, anticipatory approach to pollution problems, which seeks to avoid the closing of options for future generations (paragraph 1.13). Our recommendations on energy policy (paragraphs 5.134 and 5.144) give further expression to this need.

6.45 Such an approach, however, must be backed by adequate resources. Control of environmental pollution is not an optional extra: it is a fundamental component of national economic and social policy, and has many international implications. We have therefore been disturbed to note signs of a decreasing emphasis on environmental protection in the United Kingdom, characterised by significant reductions in the resources available for research, monitoring and forward thinking (see paragraphs 3.41, 3.51, 4.50, 5.11, 5.14 and 6.20). As a result, those concerned (particularly in central government) have been left with little capacity to do more than react to day-to-day pressures, among which the requirements of European Community membership, important though they are, can at times absorb a disproportionate amount of the available effort. We consider that the position is becoming out of balance and that it is essential to reverse this trend. We therefore **recommend** that pollution control policy, and environmental policy generally, should be accorded the priority and resources adequate for their integration in the national decision-making process, so that their potential benefits can be realised to the full and at least cost.

CHAPTER VII

CONCLUSIONS AND RECOMMENDATIONS

Recommendations are shown in bold type

7.1 'Pollution' implies harmful or unwanted effects. There is, however, no clear threshold between 'pollution' and harmless 'contamination'. Whether an emission or discharge is regarded as polluting depends on the circumstances in which it occurs, the nature and quantity of the substance, assessment of the risks, public attitudes and value judgments. (1.9–1.11).

7.2 Particular attention should be paid to substances which have persistent and bioaccumulative properties, especially where there is a risk that the environment will have insufficient time to adapt to change and that, in consequence, options may be closed for future generations. (1.12–1.13).

7.3 Progress has been made in tackling the grosser, traditional forms of pollution, but public concern about pollution, particularly that which involves newly identified hazards, remains strong. (1.20–1.21; 6.2–6.4).

7.4 There is also a growing awareness of the urgency of pollution problems which require action at the international level. (1.24; 2.3–2.5; 6.3).

7.5 Noise stands out as an environmental problem that causes much concern to the individual. However, it raises difficulties which set it apart from most of the pollution problems which fall within our field of interest. We shall continue to examine the question whether noise would form a suitable subject for a future study. (2.5; 6.16).

7.6 Straw burning is an issue of considerable current concern, where extant control measures appear to be ineffective. **The Government should announce the introduction of a legislative ban on straw burning on stubble fields to take effect in five years' time; the legislation should be introduced now and come into effect on the prescribed date without the need for subsequent statutory instruments or commencement orders.** (2.7–2.11).

7.7 **The Ministry of Agriculture, Fisheries and Food and the Agricultural and Food Research Council should give greater priority to research and development on alternative uses of straw in the immediate future.** (2.11).

7.8 We reaffirm the views expressed in previous Commission reports on the need for unnecessary secrecy to be removed. Secrecy fuels fear. **A guiding principle behind all legislative and administrative controls relating to environmental pollution should be a presumption in favour of unrestricted access for the public to information which the pollution control authorities obtain or receive by virtue of their statutory powers, with provision for secrecy only in those circumstances where a genuine case for it can be substantiated.** (2.77).

7.9 **The information to be recorded in the public registers under Part II of the Control of Pollution Act 1974 should be prescribed in accordance with our general principles and in a way which minimises the cost of providing public access.** (2.78 i).

7.10 **Section 28(7) of the Health and Safety at Work etc. Act 1974 should be amended to remove the obsolete and unnecessary bar on disclosure of information by the Industrial Air Pollution Inspectorate and other pollution control authorities.** (2.78 ii).

7.11 **Consideration should be given to establishing public registers of information relating to the control of atmospheric pollution from both registered and non-registered works, containing details of agreed 'best practicable means' and the results of emission tests and environmental monitoring by both the Industrial Air Pollution Inspectorate and local authorities.** (2.78 iii).

7.12 **The powers of local authorities under sections 79 and 80 of the Control of Pollution Act 1974 to obtain and publish information about atmospheric pollution should be made mandatory and brought into line with Part II of the Act; this should include restoration of the Secretary of State's role as final arbiter on what constitutes a trade secret.** (2.78 iv).

7.13 **As an interim measure, positive encouragement should from now on be given to local authorities to make use of their powers under sections 79 and 80 of the Control of Pollution Act 1974 and to establish local consultative committees. Local authorities should also be encouraged to make available regular information on their pollution control activities generally, for example in the form of annual reports by environmental health departments.** (2.78 v).

7.14 **In accordance with our general recommendation, the introduction to the environment of all potentially polluting substances, manufactured products and wastes should in general be subject to a uniform system of controls, with provision for public information modelled on Part II of the Control of Pollution Act 1974. Administrative and statutory requirements for public information, including those relating to pesticides, radioactive waste, new chemicals and transfrontier hazardous waste shipments should therefore be brought progressively on to a common footing.** (2.78 vi).

7.15 **Where a Minister or other pollution control authority has the power to withhold information in the public interest, the power should be exercised only when this is essential on grounds of national security.** (2.78 vii).

7.16 **In cases where protection of trade secrets is agreed to be justified, the position should be reviewed regularly and Ministerial certificates withdrawn or varied at the earliest opportunity.** (2.78 viii).

7.17 **The Department of the Environment should produce a revised edition of Pollution Paper 9 as soon as possible and keep it regularly updated.** (3.2).

7.18 We endorse the objectives of the European Community's Third Environment Action Programme, in particular its emphasis on preventive action and the integration of environmental with other policies. (3.11–3.12).

7.19 We believe that the United Kingdom should be less on the defensive and should play a more positive role in promoting environmental matters in the European Community. (1.24; 3.17–3.26).

7.20 Foresight and prudence suggest that the United Kingdom should reappraise its stance on irretrievable discharges to the sea of toxic substances which are unarguably persistent and bioaccumulative. (3.26).

7.21 We believe the concept of a 'black list' is a reasonable one, but that attention should now be given to reassessing the contents of that list. (3.26).

7.22 The concept of 'best practicable environmental option' is important, both domestically and internationally. (3.27–3.30; 6.33–6.36).

7.23 The Government should pursue with greater urgency the proposals in its response to the Commission's Fifth Report. (3.31–3.33).

7.24 We reaffirm the importance of making greater use of the expertise of local environmental health officers in monitoring and enforcing pollution control at premises registered with the Industrial Air Pollution Inspectorate. (3.34).

7.25 **Greater encouragement should be given to local authorities to pool resources in the use of manpower and equipment for pollution control.** (3.37).

7.26 **The Confederation of British Industry's proposal for a high-level advisory body to consider cross-media pollution issues should be examined in detail by the Department of the Environment.** (3.39).

7.27 We regret the winding up of the Clean Air Council and the Noise Advisory Council and the putting into abeyance of the Commission on Energy and the Environment. (3.41).

7.28 **The terms of reference of either the Radioactive Waste Management Advisory Committee or the Advisory Committee on the Safety of Nuclear Installations should be extended to cover the transport of nuclear materials.** (3.42).

7.29 **The Radioactive Waste Management Advisory Committee's membership should be enlarged to include people with local government experience.** (3.44).

7.30 **The board of the Nuclear Industry Radioactive Waste Executive should be enlarged to include independent members, appointed by the Secretary of State for the Environment, who are able to speak from a knowledge of wider public concern and to contribute suitable scientific and environmental expertise.** (3.45).

7.31 We adhere to the recommendation of the Commission's Seventh Report that the voluntary Pesticides Safety Precautions Scheme should be given statutory force. (3.48).

7.32 We consider that, within Government, arrangements for the formulation of environmental policy need strengthening. (3.51).

7.33 We see a continuing role for the Royal Commission as an independent 'watch-dog' body in the field of environmental protection. (3.53).

7.34 The water quality of some estuaries still gives cause for concern, though the worst of the fears expressed by the Commission in 1972 have not been realised. Recession and industrial restructuring, as well as statutory pollution control measures and technological development, have contributed to substantial reductions in estuarine pollution over the last decade. (4.9–4.10).

7.35 The Department of the Environment should ensure that the quality, coverage and continuity of the river quality survey are maintained. (4.13).

7.36 The Mersey is the worst remaining estuarine black spot in the United Kingdom. We support the Government's initiative for improving river water quality throughout the Mersey catchment area. Long-term plans for the area should not be upset by short-term financial expediency. (4.15–4.16).

7.37 The availability of funds, rather than further statutory powers, is the principal key to further improvements in estuarine and coastal water quality. When money is limited, it is better to concentrate on improving particular stretches of the most polluted rivers and estuaries rather than trying to raise all stretches to the highest category. (4.22).

7.38 We are concerned that the Government's announced timetable for bringing into effect the majority of the provisions of Part II of the Control of Pollution Act 1974 may not be achieved. Pollution problems should be tackled in an order of priority that has been determined on its merits and in accordance with a firm timetable, not on grounds of expediency or merely in response to the pressure of international obligations. We urge the Government and water authorities to take a longer-term view when setting future water quality targets. (4.36; 4.49).

7.39 **The Government should reaffirm the commitment to complete the legal implementation of Part II of the Control of Pollution Act 1974 by July 1986; furthermore, the Government and the water authorities should agree a timetable for the review of all categories of discharge initially covered by exemption orders or by deemed consents, and should agree a planned programme of improvement geared to stated water quality objectives.** In this way there will be a series of clear targets against which the real effects of Part II on the quality of estuarine and coastal waters can be measured. (4.36).

7.40 Water authorities should be as open as possible when setting the priorities for their own programmes and should be readily accessible to their customers and to the public in general. Water authorities should consider carefully the advantages of holding or continuing to hold their meetings in public. (4.38; 4.44).

7.41 The Department of the Environment should take a more central role in the development of a long-term research strategy for the water industry. The industry itself should ensure that it does not neglect to make use of the research expertise available in the universities and Research Councils as well as in its own organisation. We therefore welcome the Department's proposal to set up a new Research Requirements Committee in relation to the needs of the water industry. (4.50–4.51).

7.42 Many bathing waters and beaches on the United Kingdom coast suffer from an undesirable degree of contamination by sewage. (4.67).

7.43 The risk of infection by serious disease is small but the visible presence of faecal and other offensive materials can mean a serious loss of amenity and is therefore an unacceptable form of pollution. (4.67).

7.44 With well designed outfalls the discharge of sewage to the sea is in many cases the best practicable environmental option. (4.68).

7.45 **After discussion with the water industry the Government should set a date by which the recommendation of the Working Party on Sewage Disposal relating to discharges of crude sewage is to be implemented in full.** (4.68).

7.46 We believe that the selection criteria used by the United Kingdom to identify bathing waters, under the European Community bathing water Directive, were unrealistic. (4.69).

7.47 **The Government, in consultation with the water authorities and district councils, should reconsider the selection criteria and investigate with the Commission of the European Communities the possibility of identifying additional bathing waters.** This action would provide an incentive for general improvement in quality of bathing waters and beaches. (4.69).

7.48 **The Government should initiate negotiations with the Commission of the European Communities with a view to introducing a better sampling and analysis regime for coliform bacteria.** (4.69).

7.49 The problem of marine litter washed up on to beaches is a particularly difficult one, but some action can be taken. (4.70).

7.50 **The Government should ratify the MARPOL Convention and draw the attention of shipowners to the provisions of Annexe V.** (4.70).

7.51 **The Government, in association with the Keep Britain Tidy Group and the local authority associations, should give high priority to improving public education on the problem of marine litter and to encouraging appropriate authorities, for example at marinas and on ferries, to provide adequate means for the disposal of shipboard litter.** (4.70).

7.52 The state of the part of the County Durham coastline affected by tipping of colliery waste is quite unacceptable. **An early date, at least within five years, should now be set by which all tipping of colliery waste on the foreshore of the United Kingdom must come to an end, and plans should be put in hand for remedial action on the affected beaches. Such remedial action should not entail any extension of existing offshore dumping operations.** (4.71).

7.53 We see no advantage in the negative approach which the United Kingdom has adopted to the implementation of the European Community shellfish waters Directive. **The responsible authorities (the Water Authorities in England and Wales, and the Scottish Development Department) should make positive use of the enhanced powers in Part II of the Control of Pollution Act 1974 to achieve a programme of continually expanding improvement, to the benefit of both the environment and human health, and in the interests of successful commercial shellfish farming.** (4.77).

7.54 The North Sea provides a good example of the international dimension to many of the current pollution issues. (4.79).

7.55 The present international agreements are essential for maintaining the health of the North Sea. (4.99).

7.56 **The Government should respond positively to the initiatives of the Federal German Government and the Commission of the European Communities concerning the North Sea, and should promote international sponsorship of a review by an independent group of experts.** (4.101).

7.57 **Further studies should be undertaken on the inputs and effects of contaminants to the Irish Sea.** (4.101).

7.58 There have been major improvements in air quality over the last quarter of a century. The current problems are often on a regional or global, rather than a local, scale and of a long-term nature. (5.2–5.6).

7.59 We welcome the changes to the National Air Pollution Survey and support the philosophy of long-term baseline monitoring networks backed up by additional secondary networks. (5.7–5.18).

7.60 **The Department of the Environment should give greater recognition to the importance of long-term monitoring as a basis for action to improve air quality.** (5.18).

7.61 **Further consideration should be given to the size of the baseline rural network.** (5.18).

7.62 **The Warren Spring Laboratory, in liaison with the Department of the Environment and with research scientists who use the data, should continue to improve methodology for the measurement of sulphur dioxide, smoke and the wet and dry deposition of other substances.** (5.18).

7.63 **The number of sites in the baseline networks for the monitoring of nitrogen oxides and ozone should be increased substantially.** (5.18).

7.64 Effective insulation to conserve energy should not mean inadequate ventilation. (5.20–5.21; 5.52).

7.65 From none of the substances usually encountered in the air in the home (with the notable exception of tobacco smoke) is there likelihood of damage to health in most circumstances. (5.48).

7.66 **Priority should be given to devising effective remedial measures for those existing houses where radon concentrations are such as to cause anxiety, and to devising preventive measures for new houses.** (5.49).

7.67 When this has been achieved, **remedial action should be undertaken on existing dwellings, initially on those where the annual effective dose equivalent exceeds 25 mSv.** (5.49).

7.68 **A design limit should be applied to new dwellings. On the basis of information available to us we favour an annual effective dose equivalent limit of 5 mSv, but a decision on the value should await the assessment of recommendations in the forthcoming report on controllable sources of radiation by the International Commission on Radiological Protection.** (5.49).

7.69 The Government should monitor closely the results of research on the effects of formaldehyde on health, and should ensure that the highest standards of installation of cavity wall foam are maintained, but we see no need for further regulations at present. (5.50).

7.70 The problems of the most hazardous forms (blue and brown) of asbestos concern the removal and disposal of materials which have been used in the past and are still present in buildings. We believe that if the existing codes of practice and guidelines are followed the risk to the general public will be negligible. **The Department of the Environment should pay particular attention to ensuring, through suitable publicity, that advice on asbestos reaches the important target of smaller builders and do-it-yourself enthusiasts.** (5.51).

7.71 So far as other indoor contaminants are concerned, we believe that vigilance will ensure early recognition of future problems. (5.52).

7.72 **In parallel with the continuing research into indoor air quality and the role of ventilation in relation to building design, energy conservation and health, central and local government, the Health Education Council and the Scottish Health Education Group should actively promote greater public awareness of the importance of maintaining reasonable ventilation in the home, particularly where flueless heating appliances are in use.** (5.52).

7.73 We welcome the attention being paid to motor vehicle emissions by the Commission of the European Communities and by other bodies. (5.69).

7.74 Motor vehicle emissions are relevant to problems of photochemical oxidant formation and acid deposition. (5.69).

7.75 We do not attempt to reach definitive views on whether further reductions in motor vehicle emissions are desirable or on the priorities and relative merits of different technologies. (5.69).

7.76 **The route taken to implement the Government's stated intention to introduce unleaded petrol should not involve an increase in the total amount of carcinogenic hydrocarbons emitted from the vehicle population.** (5.70).

7.77 **The Department of Transport should institute urgently a programme of research into the use of electronic engine control systems and other forms of engine technology to make the quality of emissions from diesel-engined vehicles less dependent on standards of engine maintenance.** (5.71).

7.78 **Greater urgency should be given to the development of more expeditious and objective methods for the measurement of smoke from diesel-engined vehicles both at testing stations and at roadsides.** (5.71).

7.79 **Legislative provision should be made to enable local authorities to take proceedings directly against operators of vehicles emitting excessive smoke.** (5.71).

7.80 Photochemical pollution is of more frequent and widespread occurrence than until recently realised, and may have economic implications in relation to crop yields. (5.72–5.77).

7.81 **The Research Councils should encourage continued research on secondary pollutants, particularly the photochemical oxidants, in the United Kingdom.** (5.77).

7.82 Acid deposition is widespread throughout the northern temperate regions and is one of the most important current pollution issues. (5.78–5.96; 6.10).

7.83 There are still considerable uncertainties about the physical and chemical processes leading to acid deposition. (5.80; 5.91).

7.84 The ecological effects in freshwater associated with increasing acidity are fairly well recorded but the cause of acidification is often a matter of controversy. However, the effects of acidification on terrestrial ecosystems are still unclear. (5.82–5.87).

7.85 We note the Government's acceptance that sulphur dioxide and nitrogen oxides transported from United Kingdom air space may make an appreciable contribution to acid deposition in other European countries. (5.92).

7.86 We do not feel able to make detailed recommendations on acid deposition on the basis of our brief study and we may consider the subject again in the future. In the meantime **high priority should be given to research on acid deposition, in particular on the causes and effects, on the interactions with other pollutants, and on remedial action.** (5.96).

7.87 **The Central Electricity Generating Board should introduce on a pilot basis, over the next five years, certain of the sulphur dioxide abatement options that are already available.** (5.96).

7.88 There has been a recent reduction in scientific concern about stratospheric ozone depletion and its effects. It is important to consider the role of gases other than chlorofluorocarbons. (5.113–5.114).

7.89 **Industry should be encouraged to restrict the use of gases (including chlorofluorocarbons) which may deplete stratospheric ozone to purposes for which no acceptable substitutes exist.** (5.114).

7.90 **The Government should take the initiative through the European Community, the Organisation for Economic Co-operation and Development, and other international agencies, to encourage a worldwide policy to restrict the use of gases (including chlorofluorocarbons) which may deplete stratospheric ozone to essential purposes.** (5.114).

7.91 The effects of increased atmospheric concentrations of carbon dioxide could be very great indeed as could be the international measures needed to reduce emissions. (5.130).

7.92 **All necessary steps should be taken to ensure that there is the best chance of an early resolution of the uncertainties surrounding the effects of increasing concentrations of carbon dioxide in the atmosphere.** (5.130).

7.93 By far the greatest contribution to the increase of atmospheric carbon dioxide comes from the burning of coal; the governments of a relatively small number of countries hold the key to international action to reduce anthropogenic emissions. (5.132).

7.94 The United Kingdom should be ready to start switching energy sources if the results of research suggest an appreciable risk of the more pessimistic predictions concerning atmospheric pollution becoming true. (5.134).

7.95 **An appraisal of alternative energy scenarios, in preparation for a possible progressive shift away from fossil fuels, should be given the highest priority, and the Government should regularly inform Parliament and the public of its current assessment of future energy requirements and their sources.** (5.134).

7.96 We support a modest increase in nuclear power capacity as part of a strategy for reducing dependence on fossil fuels as a primary energy source and for reducing the polluting effects of their combustion. (5.138).

7.97 Since so many of the important environmental issues of the remaining years of this century are closely bound up with energy policy, the Government must have at its disposal broadly-based advice of the highest quality in this field. (5.140).

7.98 **The Commission on Energy and the Environment should be reconstituted, but with wider terms of reference in accordance with the original recommendation in the Royal Commission's Sixth Report.** (5.144).

7.99 We welcome the growing recognition by industry of the positive benefits of environmental improvement and the need to share information more freely. The economic benefits of environmental legislation may merit further research. (6.7-6.8; 6.21-6.22).

7.100 Past practices have created major and in some cases intractable pollution problems. As the European Community's Third Action Programme emphasises, prevention is better than cure. It is essential to guard against creating similar problems for the future, particularly when developing newer industrial activities. (6.12–6.14; 6.37).

7.101 **The Department of the Environment should give high priority to further research on the potentially polluting effects of electronics, bioengineering and other technologically advanced industries.** (6.14).

7.102 **Local and other statutory authorities should continue to apply the same pollution control standards in Enterprise Zones as elsewhere.** (6.14).

7.103 We have concluded that our next study should be concerned with pollution by wastes, including the problem of land contamination. (6.15).

7.104 Retrofitting of pollution control equipment and accumulated waste clearance operations are almost invariably more expensive for industry than planned programmes of pollution abatement and elimination at source. (6.20; 6.29).

7.105 It is in the national interest to have a successful pollution abatement industry. High environmental standards create a strong home market and provide opportunities for exports of technology and equipment. We welcome the initiatives taken by the Commission of the European Communities and the United Kingdom Government to encourage new pollution abatement technology. **The Government should undertake a study of the operation of subsidies for pollution control equipment and for clean technology in other Member States and should evaluate the consequences of the incorporation of similar arrangements in United Kingdom environmental policy.** (6.23–6.27).

7.106 The concept of 'best practicable environmental option' (BPEO) now needs to be reinforced by a concept of 'best environmental timetable' (BET), to ensure the optimum allocation of resources to pollution abatement. (6.31–6.32).

7.107 Continuity and anticipation are the key features of BET: with pollution control requirements announced well in advance, and adhered to firmly, industry is in a position to plan and invest with confidence. (6.37–6.43).

7.108 It is essential to reverse a decreasing emphasis on environmental protection in the United Kingdom, characterised by significant reductions in the resources available for research, monitoring and forward thinking. (6.45).

7.109 Control of environmental pollution is not an optional extra; it is a fundamental component of national economic and social policy, and has many international implications. **Pollution control policy, and environmental policy generally, should be accorded the priority and resources adequate for their integration in the national decision-making process, so that their potential benefits can be realised to the full and at least cost.** (6.45).

Acknowledgement

In closing, we wish to record our gratitude to the very many people who have contributed to our wide-ranging study. In Appendix 2 we have sought to list in full the record number of persons and organisations who have helped us, in some cases more than once, with written and oral evidence, information, advice and constructive criticism. To any who may have inadvertently slipped through the net we offer apologies as well as thanks. We wish also to pay tribute to two of our colleagues, whose appointments to the Commission ended during the course of the study: Professor Donald Acheson, who left the Commission after publication of the Ninth Report in April 1983, was much involved in the earlier stages of the study; and Professor David Williams, whose departure in July 1983 marked the end of nearly seven years' service with the Commission, participated in the study virtually throughout and has asked to be associated with the conclusions and recommendations of this Report. Finally, it is a pleasure, and no mere formality, to record our appreciation of the admirable services of our Secretariat, whose versatility and energy continue unabated.

ALL OF WHICH WE HUMBLY SUBMIT FOR YOUR MAJESTY'S GRACIOUS CONSIDERATION

RICHARD SOUTHWOOD (Chairman)
CRANBROOK
NATHAN
CHRISTOPHER BLAKE
ROBERT CLARK
BARBARA CLAYTON
GORDON FOGG
ROBERT CUMMINGS
CHARLES SUCKLING
ALBERT ARCHER
JOHN EDMONDS
GEOFFREY LARMINIE
RICHARD THORNTON
MARY WARNOCK

T. E. Radice	(Secretary)
M. G. Schultz J. M. Wilkinson	(Assistant Secretaries)

October 1983

APPENDIX 1

MEMBERS OF THE COMMISSION

during the period of study leading to the present Report

(with appointments current at 1 January 1984 unless otherwise indicated)

Chairman:

PROFESSOR SIR RICHARD SOUTHWOOD, MA, PhD, DSc, ARCS, FIBiol, FRS
Linacre Professor of Zoology, University of Oxford
Fellow of Merton College, Oxford
Vice-President, Royal Society
Honorary Foreign Member, American Academy of Arts and Sciences
Chairman of the Trustees, British Museum (Natural History) (until December 1983)
Member, National Radiological Protection Board

Members:

*E. D. ACHESON, ESQ, MA, DM, FRCP, FFCM, MFOM (until 30 April 1983)
during membership of the Commission
Professor of Clinical Epidemiology and Director, MRC Environmental Epidemiology Unit, University of Southampton
Honorary Consultant Physician to the Royal South Hants Hospital
Member, University Grants Committee
Chairman, Southampton and South West Hampshire Health Authority
Chairman, MRC Advisory Group on Lead and Neuropsychological Effects in Children
from 1 January 1984
Chief Medical Officer, Department of Health and Social Security, Home Office and Department of Education and Science
Chief Medical Adviser, Department of the Environment and Ministry of Agriculture, Fisheries and Food

A. ARCHER, ESQ, MBE, FIEH
Vice-President, National Society for Clean Air
Honorary Research Fellow, Department of Chemistry, University of Aston in Birmingham
President, Institution of Environmental Health Officers (until December 1983)
Chairman, Standing Conference of Co-operating Bodies: Investigation of Air Pollution, Warren Spring Laboratory (until June 1983)
Formerly City Environmental Officer, Birmingham

PROFESSOR C. BLAKE, MA, PhD, FRSE
Bonar Professor of Applied Economics and Dean of the Faculty of Arts and Social Sciences, University of Dundee
Vice-President, Royal Society of Edinburgh
Member, Environment and Planning Committee, Economic and Social Research Council
Member, Committee on Industrial and Social Conditions, Scottish Council Development and Industry
Member, Council for Applied Science in Scotland

*PROFESSOR R. B. CLARK, DSc, PhD, FIBiol, FLS, FRSE
Professor of Zoology, University of Newcastle upon Tyne
Member, Natural Environment Research Council
Editor, *Marine Pollution Bulletin*

PROFESSOR B. E. CLAYTON, CBE, MD, PhD, FRCP, FRCPath
Dean of the Faculty of Medicine and Professor of Chemical Pathology and Human Metabolism, University of Southampton
Honorary Consultant to the Southampton and South West Hampshire Health Authority
Chairman, Joint Committee on Medical Aspects of Water Quality
Deputy Chairman, DHSS Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment
Member, DHSS Standing Medical Advisory Committee
Member, MRC Advisory Group on Lead and Neuropsychological Effects in Children
Member, British Paediatric Association

THE RT. HON. THE EARL OF CRANBROOK, MA, PhD, FLS, FRSA
Member, Sub-Committee G (Environment), House of Lords Select Committee on the European Communities
Member, House of Lords Select Committee on Science and Technology
Member, Natural Environment Research Council
Trustee, British Museum (Natural History)
Vice-President, National Society for Clean Air

R. H. CUMMINGS, ESQ, OBE, BSc, PhD, FInstPet, FGS, FIMM, MIGeol, FMinE
Chairman and Chief Executive, Robertson Research Group

J. W. EDMONDS, ESQ, MA
Industrial Officer, General, Municipal, Boilermakers and Allied Trades Union
Member, TUC Nationalised Industries and Fuel and Power Industries Committees

PROFESSOR G. E. FOGG, CBE, BSc, PhD, ScD, Hon LLD, FIBiol, FRS
Professor of Marine Biology, University College of North Wales
Chairman, Council of the Freshwater Biological Association
Chairman, Scientific Advisory Committee, British Antarctic Survey
Trustee, Royal Botanic Gardens, Kew
Trustee, British Museum (Natural History)

*F. G. LARMINIE, ESQ, OBE, MA
General Manager, British Petroleum Environmental Control Centre
Member, Natural Environment Research Council
Member, Council of the Marine Biological Association of the United Kingdom
Trustee, Bermuda Biological Station

THE RT. HON. LORD NATHAN, MA, FSA, FRSA, FRGS
Senior Partner, Herbert Oppenheimer Nathan & Vandyk, Solicitors
Chairman, Sub-Committee G (Environment), House of Lords Select Committee on the European Communities
Vice-President, and member of the Environment Committee, Royal Society of Arts
Member, Watt Committee on Energy

C. W. SUCKLING, ESQ, PhD, DSc, CChem, FRSC, FRS
Consultant in science, technology and innovation
Non-executive Director, Albright and Wilson Ltd.
Visiting Professor, University of Stirling
Member, Science Consultative Group, British Broadcasting Corporation
Member, Biosciences Sub-Committee, University Grants Committee
Member, Electricity Supply Research Council

*R. E. THORNTON, ESQ, OBE, DL, JP, MA
Farmer
Member, Council of the Country Landowners' Association
Formerly member, Thames Water Authority

*DAME MARY WARNOCK, DBE, MA, BPhil, FCP
Writer and broadcaster
Senior Research Fellow, St. Hugh's College, Oxford
Chairman, Advisory Committee on Animal Experiments
Chairman, Committee of Inquiry into the Implications of *in vitro* Fertilisation

*PROFESSOR D. G. T. WILLIAMS, MA, LLB, LLM (until 30 June 1983)
President of Wolfson College, Cambridge
Rouse Ball Professor of English Law (from 1 December 1983) and previously Reader in Public Law, University of Cambridge
President, National Society for Clean Air
Formerly member of the Clean Air Council and the Commission on Energy and the Environment

*As indicated above and on page 191, the terms of office of Professor Acheson and Professor Williams ended before the study was completed. The terms of office of Professor Clark, Mr. Larminie, Mr. Thornton and Dame Mary Warnock ended on completion of the report.

APPENDIX 2

ORGANISATIONS AND INDIVIDUALS CONTRIBUTING TO THE STUDY

Listed below are those organisations and individuals who contributed to the survey that helped the Commission choose the subjects for its Ninth Report, for this Tenth Report and for the next study (see paragraphs 1.3 and 6.15 of this Report); and those who gave evidence or assisted the Commission in other ways during the present study.

Those organisations and individuals marked * gave oral evidence at formal Commission meetings; those marked † gave oral evidence during visits by the Commission, including those to north east England (22–24 March 1982) and Merseyside (9 June 1982). Where a submission from an academic institution has been a collective effort, we list the institution itself rather than attempt to acknowledge individual contributors.

Government Departments

Department of Agriculture and Fisheries for Scotland
Department of Agriculture for Northern Ireland
Department of Energy
Department of the Environment* (including Building Research Establishment)
Department of the Environment for Northern Ireland
Department of Health and Social Security
Department of Industry (including Warren Spring Laboratory)
Department of Trade
Department of Transport* (including Transport and Road Research Laboratory)
Home Office
Ministry of Agriculture, Fisheries and Food* (including Fisheries Laboratories)
Ministry of Defence
Scottish Development Department
Scottish Home and Health Department

Other organisations

Aberdeen University (including Departments of Botany, Engineering, Microbiology and Zoology)
Agricultural and Food Research Council (including research establishments)
Anglian Water Authority

Association of Applied Biologists
Association of Consulting Engineers
Association of County Councils
Association of District Councils
Association for the Protection of Rural Scotland
Association of Public Analysts
Association of Scientific, Technical and Managerial Staffs, No. 3 Divisional Council
Association of Sea and Air Port Health Authorities
Aston in Birmingham University (including Joint Unit for Research on the Urban Environment)
Atomic Energy Research Establishment, Harwell

Bolton Metropolitan Borough Council
Boroughs of Cleveland Pollution Control Group†
British Airports Authority
British Beekeepers' Association
British Ecological Society
British Gas Corporation
British Railways Board

Central Electricity Generating Board
Chemical Industries Association
Cleveland County Council†
Cleveland Trust for Nature Conservation†
Clyde Estuary Amenity Council
Clyde River Purification Board
Coastal Anti-Pollution League Ltd.
Commission of the European Communities†
Committee of Vice Chancellors and Principals
Confederation of British Industry*
Conservation Society
Convention of Scottish Local Authorities
Council for Environmental Science and Engineering
Council for the Principality
Council for the Protection of Rural England†
Countryside Commission
Countryside Commission for Scotland
Crown Estate Commissioners

Durham County Conservation Trust Ltd.†
Durham County Council
Durham University

Easington District Council†
Eastern Sea Fisheries Joint Committee
Embassy of the Federal Republic of Germany
Essex University (Department of Biology)

Field Studies Council
Ford Motor Company Ltd.
Forestry Commission
Forth River Purification Board
Friends of the Earth†

Gateshead Metropolitan Borough Council†
Greater London Council

Health and Safety Executive (including Industrial Air Pollution Inspectorate*)
Heathrow Association for the Control of Aircraft Noise
Highland River Purification Board
Hydraulics Research Station

Imperial Chemical Industries plc†
Imperial College of Science and Technology, University of London (Centre for Environmental Technology)
Industrial Gas Cleaning Association
Institute of Biology
Institute of Wastes Management
Institute for Water Pollution Control
Institution of Civil Engineers
Institution of Environmental Health Officers
Institution of Environmental Sciences
Institution of Mechanical Engineers
Institution of Municipal Engineers
Institution of Public Health Engineers
Institution of Water Engineers and Scientists

Johnson Matthey Chemicals Ltd.†

Keep Britain Tidy Group
Kent and Essex Sea Fisheries Committee

Lancashire and Western Sea Fisheries Joint Committee
Lawyers' Ecology Group
Leeds University (Dr A. G. Clarke and others)
Liverpool University (Centre for Marine and Coastal Studies)
London Borough of Greenwich

Manchester Area Council for Clean Air and Noise Control
Manchester University (Department of Town and Country Planning and Pollution Research Unit)
Medical Research Council
Meteorological Office
Metro Action Group, Newcastle upon Tyne†
Milton Keynes Association for Safety and Health

National Association of Local Councils
National Coal Board
National Farmers' Union
National Farmers' Union of Scotland

National Radiological Protection Board*
National Society for Clean Air
National Trust
National Water Council*
Natural Environment Research Council (including research establishments)
Nature Conservancy Council
Newcastle upon Tyne University
North East River Purification Board
North Tyneside Metropolitan Borough Council†
North West Water Authority†
Northumberland Sea Fisheries Committee
Northumberland Wildlife Trust†
Northumbrian Water Authority†

Open University (Dr K. Attenborough, Dr D. Elliott and Mr R. Tagg)

Political Ecology Research Group
Population Concern
Public Health Laboratory Service

Ramblers' Association†
River Blyth Association†
Road Haulage Association
Royal Society
Royal Society of Arts
Royal Society of Chemistry
Royal Society of Health
Royal Society for Nature Conservation
Royal Society for the Protection of Birds†
Royal Town Planning Institute

St. Thomas's Hospital Medical School, London (Department of Community Medicine)
Science and Engineering Research Council
Scottish Institute of Environmental Health
Scottish River Purification Boards' Association
Seaham Environmental Association
Severn Estuary Joint Committee
Severn Trent Water Authority
Sheffield University (Dr B. R. Pursall and others)
Social Science Research Council
Society of Dyers and Colourists
Society of Motor Manufacturers and Traders Ltd.
Solway River Purification Board
South Tyneside Metropolitan Borough Council†
South West Water Authority
South Yorkshire County Council
Southern Water Authority
Stirling University (Dr D. S. McClusky)

Tay River Purification Board
Thames Water Authority
Thermal Environment Company
Trades Union Congress
Tweed River Purification Board
Tyne and Wear Metropolitan County Council†
Tyneside Anti-Nuclear Campaign†

United Kingdom Particle Board Association
United Kingdom Petroleum Industry Association
University College of North Wales, Bangor (Marine Science Laboratories)
University Marine Biological Station, Millport (Professor J. A. Allen)
University of Manchester Institute of Science and Technology (Dr R. F. Griffiths)

Water Research Centre
Water Space Amenity Commission
Welsh Counties Committee
Welsh Water Authority
West Glamorgan Joint Environmental Pollution Committee

Yorkshire Water Authority

Individuals

Lord Ashby (Brandon)
Mr R. C. Baskerville (Stevenage)
Dr J. N. B. Bell (Imperial College of Science and Technology, University of London)
Dr J. A. Charlton (University of Dundee)
Councillor J. S. Cummings (Easington District Council)†
Mr N. Haigh (Institute for European Environmental Policy)
Mr D. Hammerton (Clyde River Purification Board)*
Dr R. B. Hornick (University of Rochester, New York)
Mr M. A. Kausman (Huntingdon)
Professor J. Large (University of Southampton)*
Professor T. A. Mansfield (University of Lancaster)
Dr R. G. Mitchell (John Radcliffe Hospital, Oxford)
Professor T. O'Riordan (University of East Anglia)*
Professor D. W. Pearce (University of Aberdeen)*
Mr D. Rimington (Harrogate)
Dr D. R. Stoddart (University of Cambridge)
Dr D. J. Storey (University of Newcastle upon Tyne)*
Mr R. Taylor (Windsor)*
Dr I. Thornton (Imperial College of Science and Technology, University of London)
Professor B. A. Thrush (University of Cambridge)
Mr R. K. Turner (University of East Anglia)*
Dr T. M. L. Wigley (University of East Anglia)
Mrs A. Wilks (Whitstable)

APPENDIX 3

THE COMMISSION'S INITIAL INVITATION FOR EVIDENCE, 8 December 1981

I am writing to invite your organisation to submit evidence for consideration by the Royal Commission in its next study.

As you probably know, the standing Royal Commission has been in existence since 1970 and has published eight reports. Seven years ago, in its Fourth Report ("Pollution Control: Progress and Problems") the Commission reviewed the state of environmental pollution generally and the structure for pollution control in the United Kingdom. The Report set out a programme of work for the next few years and an indication of other matters requiring attention. That programme has now been substantially completed with the four reports which followed:—

Fifth Report (January 1976): Air Pollution Control: An Integrated Approach

Sixth Report (September 1976): Nuclear Power and the Environment

Seventh Report (September 1979): Agriculture and Pollution

Eighth Report (October 1981): Oil Pollution of the Sea

The then Government's response to the Sixth Report was published in May 1977 ("Nuclear Power and the Environment", Cmnd 6820). Responses to the Fifth, Seventh and Eighth Reports are still awaited.

Under its new Chairman, Professor Richard Southwood FRS, the Commission has decided that it would be appropriate to take another look across the whole field of environmental pollution and to study both general and specific issues. The Commission wishes in particular to consider:

—Problems still outstanding from earlier reports

—Problems which the Commission has so far not tackled

—Significant changes in the way pollution problems have been perceived and tackled over the past decade, especially as a result of the UK's international obligations, and their implications for the future

—Future trends and potential problems for the environment.

Against this general framework the Commission sees a need to study most, if not all, of the following specific topics:

—Quality of estuarine and coastal waters

—The effects of confidentiality on pollution control and risk perception

—Toxic chemicals, especially control mechanisms
—Heavy metals and their effect on health
—International pollution problems
—Primary and secondary air pollution, especially by motor vehicles
—Pollution by noise.

This list is not intended to be exhaustive and the Commission would be pleased to receive, for the purposes of an initial broad review, evidence on any other problems which scientific or lay opinion considers to be a present or potential threat to the environment.

The extent to which the Commission's investigations into particular issues receive detailed treatment in the next report will depend on the nature of the problems that they reveal. The Commission will be concerned to look for gaps in the present state of knowledge and to consider the adequacy of current research and government policies for tackling existing and potential pollution problems. This will include an assessment of the response to extant advice from other sources, e.g. Parliamentary Select Committees and expert advisory bodies. On some issues therefore the Commission may be able to record that it is satisfied with the action that is being taken in other quarters. On others it may decide that the problems would be better tackled in separate, later studies.

On a more general level, the Commission will be looking at the broad principles or philosophy of pollution control, including organisational and administrative matters—e.g. the outstanding issues raised by the Commission's Fifth Report; issues of commercial confidentiality and international regulation and their effects on industrial competitiveness; the relationship between pollution and industrial growth; energy and pollution; risk analysis and perception; and the assessment of the comparative benefits of (and hence priorities for) various measures for dealing with pollution.

A possible subject for separate study is the problem of pollution by noise, which has not been studied comprehensively since the Wilson Committee of the early 1960s. At this stage therefore the Commission would be looking for preliminary evidence on the nature of the problem and advice on any major gaps in the present state of scientific knowledge or analytical techniques which might be suitable subjects for independent research in advance of a later study.

A general invitation to submit evidence, by means of this circular letter or in similar terms, is being issued initially to all the organisations shown on the attached list*. The Commission would be happy to receive suggestions on any other organisations who might be interested in receiving a copy of this letter. In addition, the Commission will be making specific requests to Government departments and expert organisations or individuals for detailed evidence on matters which it identifies as requiring study in depth, some of which may emerge from the responses to this letter. The Commission may also wish to arrange for certain witnesses to supplement their written submissions with oral evidence.

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*The list of organisations is not reproduced.

The Commission would be grateful to receive evidence as soon as possible and in any event not later than 26 March 1982. Evidence and all other communications should be addressed to me at the above address. It would be of great assistance to the Commission, in planning its business over the next few months, if you were able to let me know at an early date whether or not your organisation proposes to submit evidence; and if it is your intention to do so, the date when the Commission can expect to receive it and the subjects likely to be covered.

Signed by the Secretary to the Commission

APPENDIX 4

The provisions of Part II of the Control of Pollution Act 1974 not in force at 31 October 1983

Introduction

1. This Appendix describes the provisions of Part II (sections 31 to 56) of the Control of Pollution Act 1974 which were not in force on 31 October 1983. The descriptions relate specifically to England and Wales. The application of Part II to Scotland is broadly similar, though there are differences on some points of detail. Of the sections listed below, all apply to Great Britain except section 45, which applies to England and Wales only. Of the sections not listed, sections 43 and 44 apply to England and Wales only and were implemented in 1974 (see paragraph 4.26 of the Report); and sections 49 and 50 (and 56) were brought into effect in England and Wales in 1976 but have yet to be brought into effect in Scotland (see paragraph 4.27 of the Report). Sections 52 (England and Wales) and 53 (Scotland), which relate to the levying by water authorities of charges in respect of discharges of trade and sewage effluent under the terms of a consent (see section 34 below), are not included below; the Government's proposals for implementation of Part II (see paragraph 4.32 of the Report) do not include these sections.

2. Part II of the Control of Pollution Act 1974 concerns the prevention of pollution of water. It extends the protection of water from pollution to virtually all inland and coastal water within the 3 mile limit and aims to improve the effectiveness of the pollution control system. New provisions are introduced to safeguard water from the risk of accidental pollution.

Section 31: CONTROL OF POLLUTION OF RIVERS AND COASTAL WATERS ETC

3. This section establishes the general offence of polluting water and defines exemptions from it. Among these are: authorisation by the Secretary of State or a water authority; authorisation under certain other legislation such as the Water Act 1945; attribution to good agricultural practice; and emergencies. There is also provision for enforcing precautionary measures to prevent pollution occurring and for the punishment of those found guilty of polluting water. *Regulations* under this section will provide:

- —for prescribing further enactments under which an authorisation to discharge polluting matter will provide exemption under the 1974 Act
- —for precautions to be taken by persons having custody and control of polluting matter so as to prevent such matter from entering 'relevant waters'
- —for the restriction, if necessary, of the carrying on of particular activities in particular areas to prevent pollution of water, subject to the special procedure provision of section 104(3).

The section also empowers water authorities to make *byelaws* to prohibit or regulate the use of streams or 'controlled waters' for washing or cleaning.

Section 32: CONTROL OF DISCHARGES OF TRADE AND SEWAGE EFFLUENT ETC INTO RIVERS AND COASTAL WATERS ETC

4. This section extends and consolidates the controls over discharges of trade and sewage effluent which at present apply under the Rivers (Prevention of Pollution) Acts 1951 and 1961 (the former of which is to be wholly and the latter largely repealed by this Act), the Clean Rivers (Estuaries and Tidal Waters) Act 1960 (also wholly repealed) and the Water Resources Act 1963 (partly repealed). Under this section, all types of effluent discharges (other than from a vessel, or authorised under the Dumping at Sea Act 1974, or certain emergency discharges) into inland and coastal waters, up to the 3 mile limit, onto or into land or into the sea beyond coastal waters by pipe from land are controlled. Water authorities are empowered to control any highway drain as they consider necessary. They are also made responsible for the polluting effluent discharged from their own works unless it can be shown that the pollution was caused by a discharge to them which they were not bound to receive or which contravened conditions of receipt under circumstances where the authority could not reasonably have prevented its discharge to them. By an *order* under this section, made before subsection (1) comes into force (the 'relevant day'), certain discharges not subject to control under the previous Acts may be exempted for the time being from control under the section. This provision is designed to relieve pressure on water authorities in the first few years of the Act's operation by staging the absorption of certain categories into the system. Such an order—the Control of Pollution (Exemption of certain discharges from control) Order 1983 (SI 1983, No. 1182)—came into effect on 31 August 1983 (see paragraphs 4.33 and 4.34 of the Report) following the bringing into effect on 10 August of section 32(3) of the Act under the Control of Pollution Act 1974 (Commencement No. 16) Order 1983 (SI 1983, No. 1175). The other subsections of section 32 have yet to be brought into effect.

Section 33: CONTROL OF SANITARY APPLIANCES ON VESSELS

5. This section repeats and extends provisions under the 1951 Act aimed at preventing discharges from sanitary appliances on vessels. It enables water authorities to make *byelaws* prohibiting or regulating the keeping or use on non-tidal rivers or 'restricted waters' of boats with sanitary appliances which discharge into the water. 'Restricted waters', as defined in section 56(1), means designated tidal rivers and other prescribed areas, such as harbours and marinas, where vessels lie at moorings close together. The Secretary of State may provide by *order* that byelaws made under earlier legislation shall have effect as if made under this section. It is also provided that 'after 1978' boats with discharging sanitary appliances will not be allowed on non-tidal rivers unless the appliances are sealed. In addition, upon application by a water authority or a harbour authority, the Secretary of State, jointly with the Minister of Agriculture, may by *order* extend the prohibition to 'restricted waters'. By a further *order* the Secretary of State may direct that any part of any stream shall be treated as 'restricted waters' 'after 1978'. It will thus be possible to exempt from the absolute provisions of subsection (3) certain inland ports and their approaches. *Regulations* may be made requiring a person hiring out a boat provided with a sanitary appliance to give notice of prescribed provisions. *Regulations* may also be made prescribing appliances (other than sinks, baths or shower-baths) which are to be included in the term 'sanitary appliances' in addition to water closets.

Section 34: CONSENTS FOR DISCHARGES OF TRADE AND SEWAGE EFFLUENT ETC

6. Section 32 defines the types of discharge which cannot lawfully be made without consent. This section is the first of a group relating to applications for consent and to

the giving of consents. It replaces relevant provisions of the Rivers (Prevention of Pollution) Acts 1951 and 1961 and, with respect to discharges which may affect underground water, the Water Resources Act 1963. It requires an applicant to provide certain information in respect of the proposed discharge. It also requires a water authority not to withhold consent unreasonably and provides that if after 3 months (or such longer period as shall be agreed) no consent has been given and no reference made to the Secretary of State, consent is deemed refused. Under this section a water authority may regularise an illegal discharge by issuing an instrument of consent, but this will not have retrospective effect. The section also contains a list (which is not exhaustive) of the matters with respect to which reasonable conditions may be imposed on the grant of consent and also provides for penalties for making false statements in applications under the section. There are *no regulations* under this section.

Section 35: REFERENCE TO THE SECRETARY OF STATE OF APPLICATIONS FOR CONSENT

7. This section empowers the Secretary of State to 'call in' for his own determination certain applications for consent or applications of a certain kind, either as a result of representations made to him or of his own volition. If he wishes he may hold a local inquiry into the application and he is obliged to hold one or give both parties an opportunity to be heard if either request it. Any person making representations as a result of an advertisement will be entitled to be heard at any hearing requested by the applicant or water authority. *Regulations* will lay down the form in which representations to the Secretary of State shall be made.

Section 36: PROVISIONS SUPPLEMENTARY TO SECTIONS 34 AND 35

8. This section requires applications for consent under section 34 to be advertised and any written representations to be considered. These requirements also apply where consent has been granted by service of an instrument without prior publicity. Where the water authority considers a discharge will have no appreciable effect on the receiving water, it may grant consent without advertising the application. *Regulations* will:

—prescribe the form in which advertisement by a water authority shall be made

—prescribe modifications of the requirements of the section in relation to applications 'called in' by direction under section 35

—prescribe the form in which an objector may submit a request for the 'calling in' by the Secretary of State of an application to which the water authority proposes to consent

—list those 'administrative' conditions of consent which, if not met, should not attract the same degree of punishment applicable to defaulting on 'polluting' conditions.

Section 37: REVOCATION OF CONSENTS AND ALTERATION AND IMPOSITION OF CONDITIONS

9. This section re-enacts and extends provisions in the Rivers (Prevention of Pollution) Act 1961 for the review of the terms of consents for discharges (see section 34). It imposes a duty on water authorities to carry out such reviews periodically and empowers them to act to revoke the consent or modify the conditions if appropriate. The Secretary of State may direct the water authority to take such action and may also serve notice of revocation or modification on a discharger on behalf of the water authority. There are *no regulations* under this section.

Section 38: RESTRICTION ON VARIATION AND REVOCATION OF CONSENT AND OF PREVIOUS VARIATION

10. This section follows section 5 of the Rivers (Prevention of Pollution) Act 1961 in requiring consents to specify a period of not less than 2 years within which they may not be varied or revoked under section 37 without the written agreement of the person discharging under the consent. It breaks new ground in permitting earlier variation or revocation on payment of compensation, which shall not, however, be paid if there has been a change of circumstances not forseeable at the time of consent. *Regulations* will provide for the manner of determining the amount of compensation payable under the section (see section 45).

Section 39: APPEALS TO THE SECRETARY OF STATE

11. This section deals with appeals to the Secretary of State (jointly with the Minister of Agriculture in one case) against decisions of water authorities with respect to discharges into any relevant water and certain activities which may cause pollution. It specifies what matters are open to appeal and also provides that, where there is an appeal, persons who have made representations about the application shall be given opportunity to make further representations on the appeal. The section further provides that, pending decision on the appeal, the water authority's refusal or conditions of consent shall have effect save where the conditions refer to restrictions on particular activities in specified areas under section 31(5). Provision is made for reference to the High Court of any question of law. *Regulations* may be made to provide for the manner and time in which appeals may be made and for the procedure for dealing with them.

Section 40: TRANSITIONAL PROVISIONS RELATING TO CONSENTS

12. This section provides transitional arrangements to deal with:

—existing consents to discharge

—outstanding applications under existing legislation for consent to discharge

—discharges which were lawfully made or begun without consent during the year ended 30 April 1974 but which would become unlawful under the Act except with consent.

Regulations will provide for existing consents granted under the Rivers (Prevention of Pollution) Acts 1951 and 1961 or section 72 of the Water Resources Act 1963 to have effect as if given under the 1974 Act.

13. Applications under existing legislation fall into two groups: applications for consent to make a new discharge, and applications under section 2 of the 1961 Act in in respect of unaltered pre-1951 discharges. Under section 40(3), any such applications which are outstanding on the 'relevant day' (when section 32 comes into force) are to be treated thenceforth as applications under section 34 which were made on the day on which they were actually made. In general this means that the period of 3 months specified in section 34(2) for the determination of applications will run from the date the application was made, and that after the 'relevant day' a water authority will have to comply with the requirements of section 36(1) (as to advertisement, representations etc) before issuing a decision on an outstanding application. But the second group will also be covered by the provision for deemed consent in so far as the discharges in question were being made in the year ending 30 April 1974. Under section 40(4), where a discharge has been lawfully made or begun without consent in the year ending 30 April 1974 and is substantially unchanged, consent will be deemed to have been given unconditionally until the water authority actually gives or refuses consent, provided that an application for consent is made under section 34 before the 'relevant day'.

14. The intended effect of section 4(3) and (4) in relation to unaltered pre-1951 discharges being made in the year ending 30 April 1974 under cover of an application made under section 2 of the 1961 Act (and deemed by section 40(3) to have been made under section 34) is that consent will be deemed to have been given on the 'relevant day' without the need for an actual application to the water authority under section 34. In such cases the requirements of section 36(1) (advertisement etc) would only come into play when the authority wished to determine the application. Other discharges lawfully made or begun without consent in the year ending 30 April 1974 will only attract deemed consent if an application is actually made under section 34 before the 'relevant day'. Where a discharge has been lawfully begun without consent or substantially altered since 30 April 1974, an actual consent for the discharge will have to be obtained before the 'relevant day' if the discharge is not to be interrupted. Provision is also to be made by *regulations* under this section for appeals under existing legislation which are pending on the 'relevant day' to be treated as appeals under the Act.

Section 41: REGISTERS

15. This section provides for *regulations* to be made for the maintenance by water authorities of registers which will be open to public inspection. Subjects to be covered in the registers are laid down and comprise particulars of:

—applications for consents

—consents given and any conditions attached thereto

—samples of water and effluent taken by water authorities, information produced by analyses of these samples, and steps taken in consequence of this information

—certificates granted by the Secretary of State exempting applications, consents and conditions etc from publicity (see section 42)

—notices issued by the Secretary of State requiring abstention from certain agricultural practices (see section 51).

Section 42: POWER OF THE SECRETARY OF STATE TO EXEMPT APPLICATIONS, CONSENTS AND CONDITIONS ETC FROM PUBLICITY

16. This section empowers the Secretary of State to give exemption from the requirements in sections 36 and 41 regarding publicity. A person seeking exemption must apply to the Secretary of State, within a period to be prescribed by *regulations* in the case of applications for consent under section 34, and if the Secretary of State is satisfied that disclosure would prejudice unreasonably some private interest in relation to a trade secret or would be contrary to the public interest, he may issue a certificate.

Section 45: EARLY VARIATIONS OF CONDITIONS OF DISCHARGES

17. This section empowers a water authority to vary the conditions of its consent within 2 years under certain circumstances and provides for the payment of compensation where justified. *Regulations* will prescribe the manner of determining compensation and the procedure for appeals to the Secretary of State against variations without compensation (see section 38(5)). This section does not apply to Scotland.

Section 46: OPERATIONS BY WATER AUTHORITIES TO REMEDY OR FORESTALL POLLUTION OF WATER

18. This section gives water authorities substantial new powers to forestall and remedy pollution, in particular obliging them to revoke a consent or vary its conditions where a discharge in accordance with the consent causes pollution harmful to the flora

or fauna of a stream. In the latter case the authority is under a duty to restore the flora and fauna, as far as practicable, to the condition they were in prior to the discharge being made. The costs of any operations under this section may be recovered from the discharger except where the discharger is entitled to compensation for revocation or alteration of conditions of consent, the discharge is water from an abandoned mine, or a court holds that the costs were incurred unnecessarily. The authority is given discretion to allow a period of time to the discharger for making changes in or ending the discharge. There is also discretion not to revoke or modify the consent in a case where the authority believes that further discharges made after a reasonable period will not harm the flora or fauna after the authority has carried out operations for their restoration. Compensation is payable to a discharger under the same circumstances as it would be payable under section 38(4). There are *no regulations* under this section.

Section 47: DUTY OF WATER AUTHORITIES TO DEAL WITH WASTE FROM VESSELS ETC

19. The provisions of this section are linked to those of section 33. They impose a duty on water authorities to arrange for the collection of the waste from vessels which by reason of section 33 cannot be discharged into the water and to arrange for the provision of facilities for washing out appliances from vessels. The section also empowers the authority to arrange for the provision of sanitary and washing facilities for people from boats in its area. *Regulations* under this section will prescribe the appliances for which facilities for washing out must be provided.

Section 48: POWER OF WATER AUTHORITIES TO EXCLUDE UNREGISTERED VESSELS FROM RIVERS ETC

20. This section enables water authorities to make *byelaws* prohibiting boats from using specified inland waterways unless they are registered by the authority or are exempted by the byelaws from registration. The section also prescribes penalties for contravention of the byelaws and provides for a reasonable charge to be made for the registration of a vessel. It also provides that persons from vessels registered with the authority shall have free use of the sanitary and washing facilities provided under section 47. There are *no regulations* under this section.

Section 51: NOTICE TO ABSTAIN FROM CERTAIN AGRICULTURAL PRACTICES

21. This section provides the machinery for dealing with the service on a farmer of a notice under section 31(2)(c). It provides for a water authority to apply to the Secretary of State, copying the application to the Minister of Agriculture and to the occupier in question, requesting that notice be served on the occupier requesting him to prevent acts or omissions which, while in accordance with good agricultural practice, are nonetheless considered to have polluted or to be likely to pollute 'relevant waters'. The occupier has a right to make representations to the Secretary of State within 28 days and the water authority must serve him with a statement to this effect with the copy of the application. The Secretary of State is required to serve the notice applied for or one in less restrictive form or one stating that the application is rejected, in each case copying it to the water authority. The water authority is required to enter details of notices, other than notices of rejections of applications, in the appropriate register which it keeps in accordance with section 41. The Secretary of State may cancel a notice after informing the water authority of his intention to do so and the water authority must then make an appropriate entry in the register. There are *no regulations* under this section.

Section 54: EXCLUSION OF CERTAIN LIABILITY IN RESPECT OF DISCHARGES WITH CONSENT

22. This section provides that a discharge of trade effluent into a stream for which consent has been obtained under the Act shall not be an offence under the Salmon and Freshwater Fisheries Act 1923 or the Public Health Act 1875. There are *no regulations* under this section.

Section 55: DISCHARGES BY WATER AUTHORITIES

23. This section provides for Part II of the Act to have effect in relation to water authorities' own discharges with modifications to be prescribed by *regulations.* It will replace section 17(1) to (4) of the Water Act 1973 and the Water Authorities (Control of Discharges) Order 1978 made under section 254 of the Local Government Act 1972. Modifications will be necessary to replace the system of control by consent of the water authority (as laid down in sections 32 and 34) by some other form of control and it is provided that this may be by consent, actual or deemed, given by the Secretary of State.

Section 56: INTERPRETATION ETC OF PART II

24. Section 105 deals with the interpretation of terms of general application. This section deals with the interpretation of terms applying to Part II in particular. The section was brought into effect in England and Wales in 1976 but has yet to be brought into effect in Scotland.

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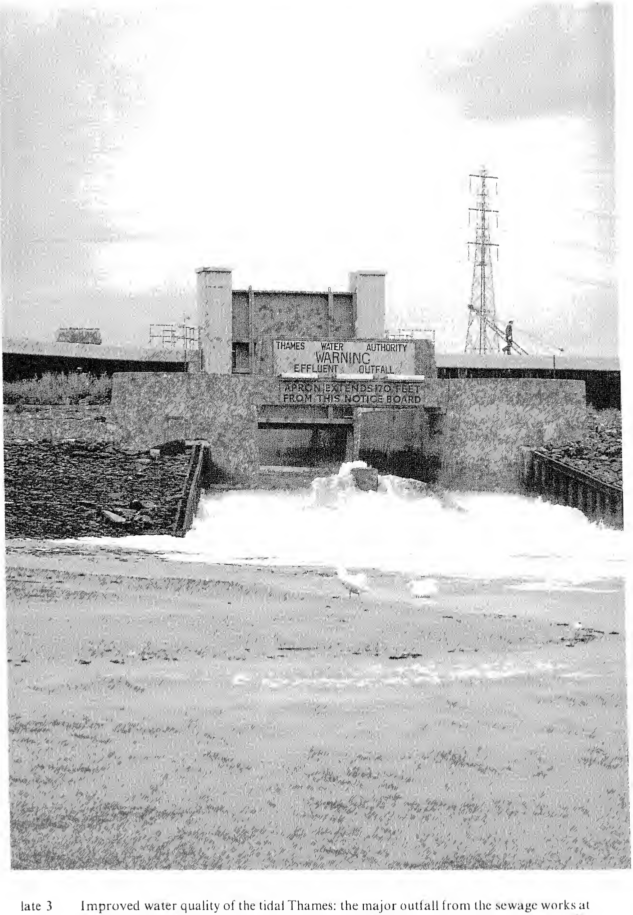
Plate 1 Smoke from stubble burning at Saltdean, near Brighton (paragraph 2.8)

Photograph by courtesy of the Brighton and Hove Gazette

Plate 2 Improved water quality of the tidal Thames: fishing at Battersea, central London (paragraph 4.19)

Photograph by courtesy of the Thames Water Authority



late 3 Improved water quality of the tidal Thames: the major outfall from the sewage works at Beckton, east London, which discharges over 800,000 m^3 of treated effluent daily (paragraph 4.19)

hotograph by courtesy of the Thames Water Authority

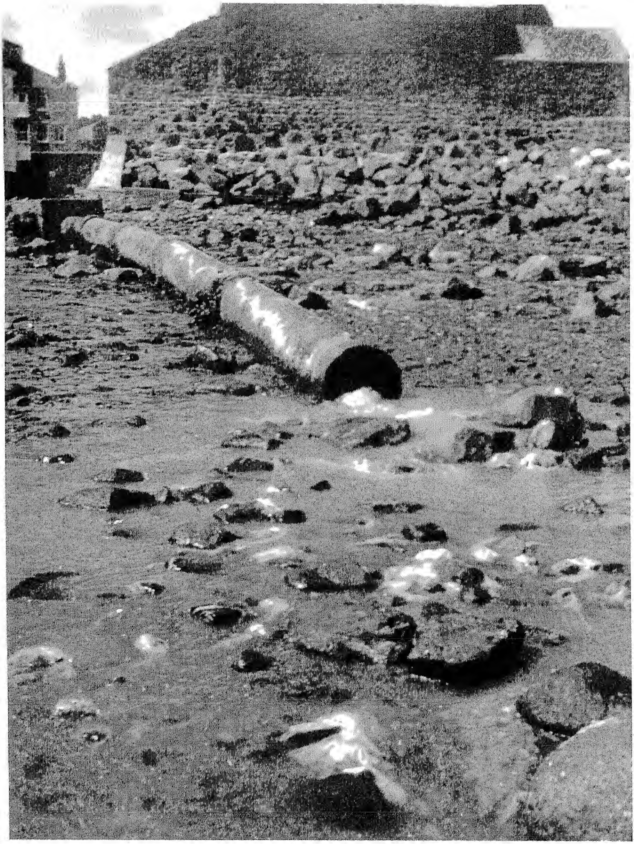


Plate 4 Outfall of untreated sewage onto the beach at Mount's Bay, Penzance (paragraph 4.53)

Photograph supplied by the Coastal Anti-Pollution League Ltd

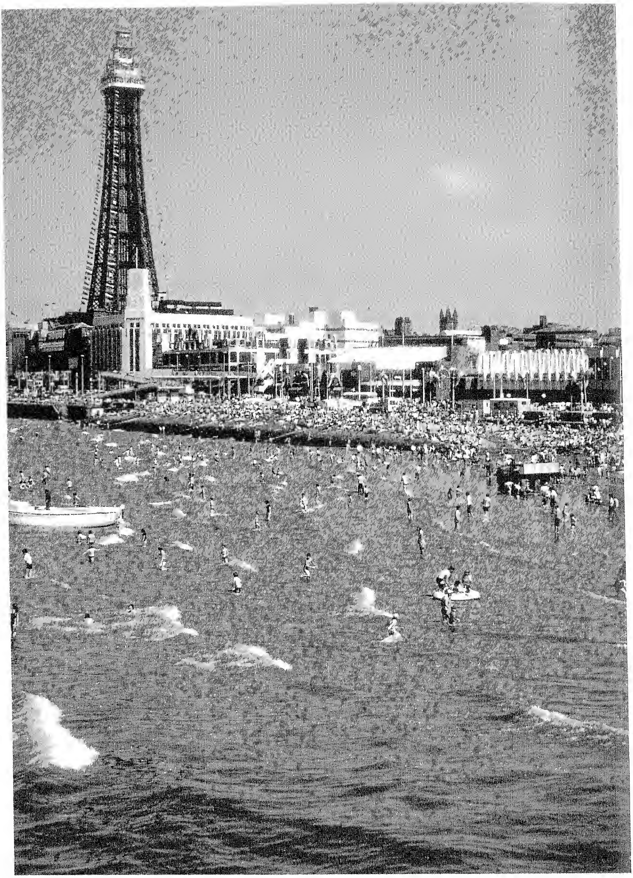


Plate 5 The bathing water at Blackpool beach – not identified as a stretch of water where bathing was 'traditionally practised by a large number of bathers' (paragraph 4.59)

Photograph by courtesy of Blackpool Tourism Department

Plate 6 Colliery waste tip and lagoon on the foreshore at Nose's Point, County Durham (paragraph 4.66)

Photograph by courtesy of Dr M G Schultz

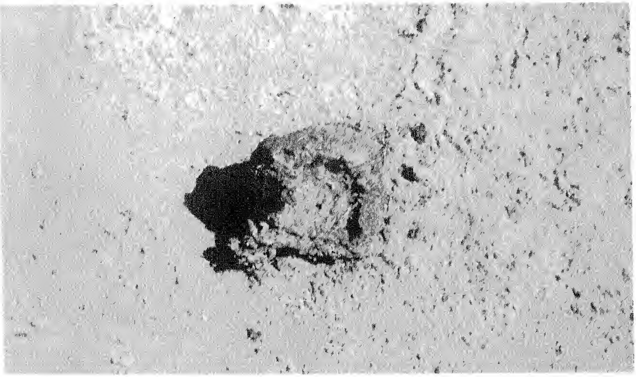


Plate 7 Pellet of fat and faecal material washed up on a Merseyside beach (paragraph 4.67)

Photograph by courtesy of the North West Water Authority

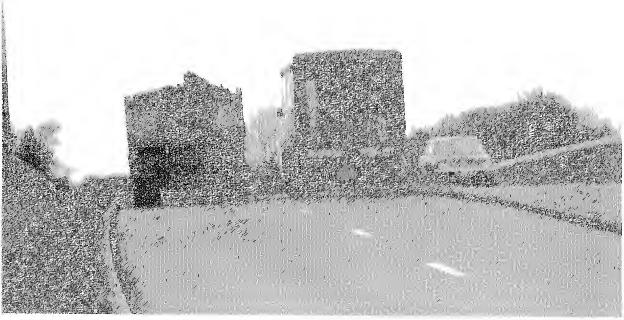


Plate 8 Smoke emissions from improperly maintained diesel vehicles constitute a continuing problem (paragraph 5.53)

Photograph from a Camera Talks Production on Pollution

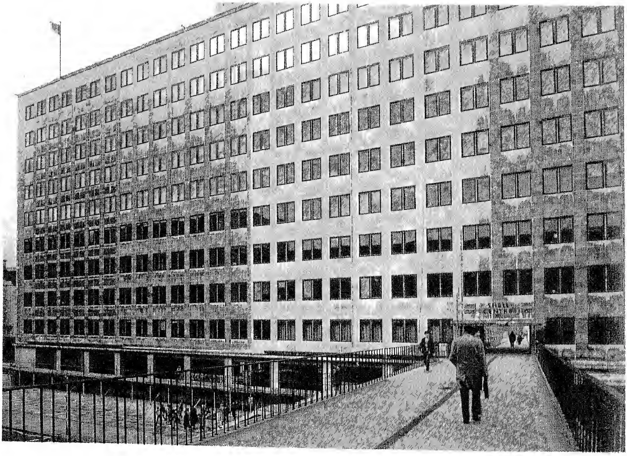
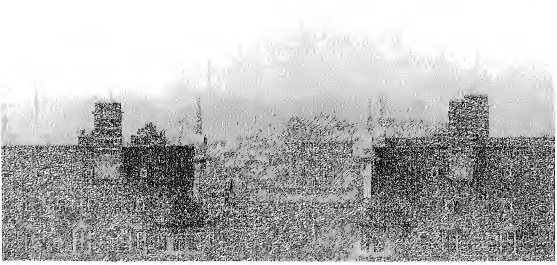


Plate 9 Soiling of a building in central London by air pollutants. The building was constructed in the early 1960s and cleaned for the first time in 1983 (paragraph 5.53)

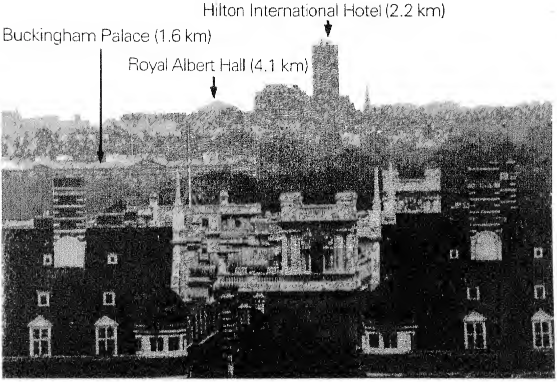
Photograph by courtesy of the Scientific Services Branch, Greater London Council



28 August 1981

Plate 10 View west across central London during periods of high (above) and low (below) atmospheric photochemical activity, showing the reduction in visibility due to photochemical haze (paragraph 5.73)

Photograph by courtesy of the Scientific Services Branch, Greater London Council


Hilton International Hotel (2.2 km)
Buckingham Palace (1.6 km)
Royal Albert Hall (4.1 km)

28 September 1981

Plate 11 Stream above Llyn Brianne Reservoir, central Wales. This stream, which is typical of the area, has been studied for the last three years and is now fishless. Rainfall acidity, land use and elevated aluminium concentrations have been implicated (paragraph 5.84)

Photograph by courtesy of the Welsh Water Authority